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# Professional development and practice: A study of early childhood teachers of mathematics

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# Professional Development and Practice: A Study of Early Childhood Teachers of Mathematics

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# ABSTRACT

In the past twenty years there has been increased interest in the ways in which teachers construct their professional lives. It is no longer assumed that preservice education alone will enable teachers to meet the challenges of their teaching lives. Ongoing professional development is seen as an essential component of contemporary teachers' lives but remains a challenge for professional development planners and providers. The nature and extent of teachers' participation in professional development was a significant dimension of the investigation of professional development contained in this thesis.

The research questions which formed the basis for the data collection in this thesis related to a specific group of teachers, early childhood teachers, and to a particular curriculum area, mathematics. The research goals were to obtain descriptive data related to teachers' professional development experiences and to explore the relationships between the realities of practice and the rhetoric of the literature on professional development, early childhood education and mathematics education. The data were obtained in the Northern Territory and came principally from questionnaire responses and interviews.

The results of this study highlight the complexities of teaching in the 1990s and indicate that early childhood teachers are faced with a number of professional dilemmas, the resolution of which indicates the need for a range of professional development interventions. The recommendations contained in the latter part of the thesis make reference to the need for the provision of a wider range of professional development options and for a greater emphasis to be placed on collegial support. The results of this study suggest that change can occur if teachers are encouraged and supported in their endeavours to improve their practice.

## DECLARATION

I certify that this thesis does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature.....

Date.....2/2/99.....

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# CHAPTER 1

# INTRODUCTION

## Genesis of the Study

In 1989 the Department of Employment, Education and Training released its report *Discipline Review of Teacher Education in Mathematics and Science.* The review was commissioned in response to criticisms of the quality of mathematics teaching in Australian schools. The final report included many recommendations for changes to the mathematics education components of preservice teacher education courses. In particular, the Discipline Review recognised the importance of career-long professional development programs for teachers organised by employers, schools, professional associations, and tertiary institutions.

Some teachers actively pursue professional development activities throughout their careers and their teaching reflects an engagement with current research and thinking on teaching and learning. Other teachers, for a variety of reasons, perpetuate and reinforce practices which are outmoded and inadequate. It is common for teachers, even after participation in professional development experiences, to find that their teaching remains the same and to feel frustrated in their attempts to change (Bell & Gilbert, 1997). One of the continuing challenges for the mathematics education community is to increase teachers' involvement in mathematics education professional development by attempting to create conditions which are likely to facilitate desirable change in education.

The federal government has attempted to foster change in mathematics education through its support for mathematics education professional development programs. In 1986, as part of the *Basic Learning In Primary Schools (BLIPS)* program, a conference, *Multiplying Chances*

*(For All)*, was held to discuss plans for a national mathematics education project similar to the successful *ELIC (Early Literacy In-service Course)* project. The conference was opened by the Chairperson of the Commonwealth Schools Commission at that time, Ms Lyndsay Connors, who said

> Mathematics at the early childhood level is often overlooked because of an understandable concern with the final years of schooling and the interface with work. It is in the early years that attitudes towards a subject and opinions about competence in a subject are formed. Mathematics teaching is being re-evaluated all over Australia, with an increased emphasis on processes, key concepts and their application rather than merely upon computational skills. The early childhood area can contribute to these new understandings because of its recognition of the importance of listening to children and of the central role of language in learning. (Connors, 1986, p. 9)

Following Ms Connors' opening remarks eight invited speakers addressed key issues related to early childhood mathematics. While speaking on professional development and teacher confidence, Noelene Reeves, from the Western Australian Department of Education, stated that early childhood teachers were hampered in their mathematics teaching by anxiety, insecurity, lack of understanding of mathematics, and lack of understanding about how children learn mathematics. She considered that if mathematics education for young children was to be improved then it was important to start considering what teachers need to know to restore confidence in themselves as mathematicians and as mathematics educators (Connors, 1986).

Gaining an understanding of how teachers acquire and maintain skills and confidence in mathematics teaching is the focus of this thesis. There is not yet substantial research which documents the long-term effects of programs which were initiated as a result of the recommendations from the *Multiplying Chances (For All)* conference. It is possible, however, to engage teachers in reflection on their recent professional development experiences

and to learn how teachers construe their own professional lives. Central to this investigative process is a search for patterns and meaning which may assist educators involved in professional development to plan and implement appropriate mathematics education activities.

## Aims of the Study

The basis of this thesis was an investigation of the mathematics education professional development of early childhood teachers. For the purposes of this study early childhood teachers are taken to be those who work with children up to eight years of age. The study focused on a particular group of teachers (early childhood) in a geographically similar context (the Northern Territory), and on a particular curriculum area (mathematics), all set in the broader Australian educational context. The particular dimensions of teachers' roles and responsibilities which were explored were their professional backgrounds, their participation in professional development activities, their mathematics teaching and their perceptions of what constituted appropriate professional development.

The aim of this research was to collect data which would lead to an increased awareness of the interests and concerns of early childhood teachers in relation to mathematics education professional development. The major research questions were:

1. What are the major elements of early childhood teachers' past personal and professional lives which have relevance for their mathematics teaching?
2. How have the professional development experiences of early childhood teachers influenced their knowledge, attitudes and interests in relation to mathematics teaching?

Associated questions, outlined in Chapter 4, sought to elicit responses that would elaborate upon the major research questions and provide data which would assist all stakeholders in professional development to plan and implement activities which might, in turn, encourage teachers to improve the quality of their mathematics teaching.

## Structure of the Study

The focus and goals for this thesis were derived from personal involvement in teacher professional development activities and in tertiary education in four Australian states and territories. Based on observations in classrooms, discussions with early childhood teachers and work with preservice teachers I felt that early childhood teachers were generally less confident and less committed to their teaching of mathematics than to other curriculum areas. This lead to the development of conjectures about why this might be so. Did early childhood teachers have less formal background in mathematics than in other curriculum areas? Did they have less opportunity to improve their professional practice in this area? If professional development activities did exist, what facilitated or hindered participation? The formation of the research questions and the subsequent study emerged from this process and from attempting to identify the most influential factors in relation to early childhood teachers' approaches to teaching mathematics.

This study did not attempt to test any particular theory but was guided, principally, by theoretical developments in education which are concerned with the nature of change. The framework for the study is shown in Figure 1 and shows how the theoretical basis for the research was informed by relevant literature in three major areas; professional development, mathematics education and early childhood education. The literature

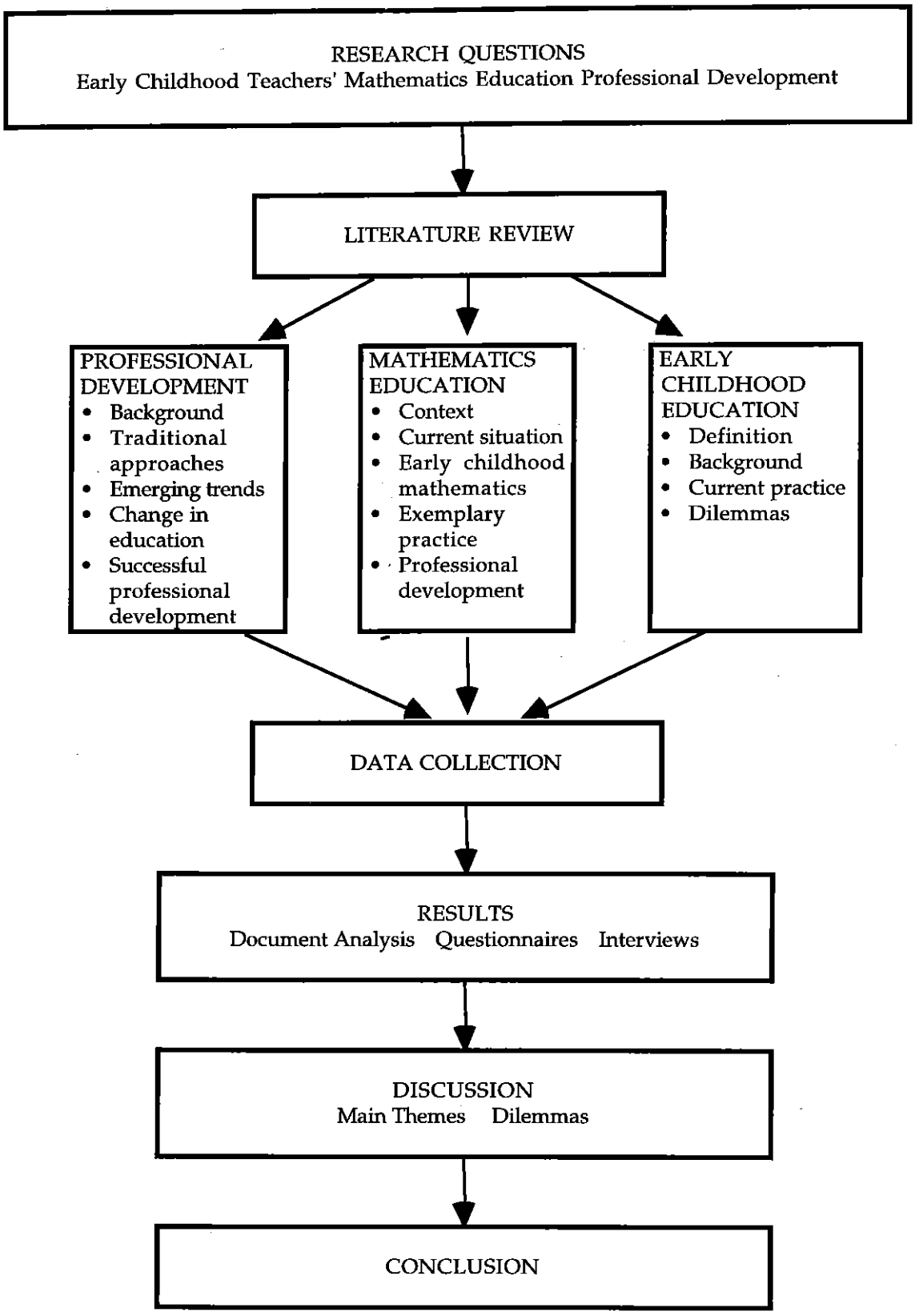


*Figure 1.* Overview of thesis content.

review and the data collection deal with these themes in isolation, and in combination, in an attempt to ascertain whether, for example, generalised principles of effective professional development apply across all curriculum areas and all sectors of the teaching community. It was hoped that the study might contribute to a reconciliation of the claims of special interest groups, such as early childhood teachers, with the thrust for large-scale reform movements in education. As well, there was an attempt to draw together threads of the various discourses to create a fabric which presents a unified picture of professional development.

## The Context

The study was set in the Northern Territory of Australia. In 1994 the Northern Territory had a total of 184 schools. This figure included primary and secondary schools from the government and non-government sectors. There were 2 615 teachers and 34 146 pupils. Over eighty percent of the Northern Territory's teachers and students were in the major centres of Darwin, Alice Springs, Katherine, Tennant Creek and Nhulunbuy. There were, however, many small schools in outlying areas (see Figure 2). The geographical isolation of many schools is illustrated by the case of Ganjarani School (Map reference C4). This particular school is situated on a cattle station (Macarthur River) near to a major mining development. By road the schools is five hours from Katherine, the nearest regional office. A return airfare to Darwin in 1994 cost $800. The nearest school is Borroloola, one and a half hours away by gravel road. It is evident from this example that the Northern Territory has particular challenges in terms of servicing schools in remote areas. This issue is highlighted in relation to the discussion of professional development in this study.

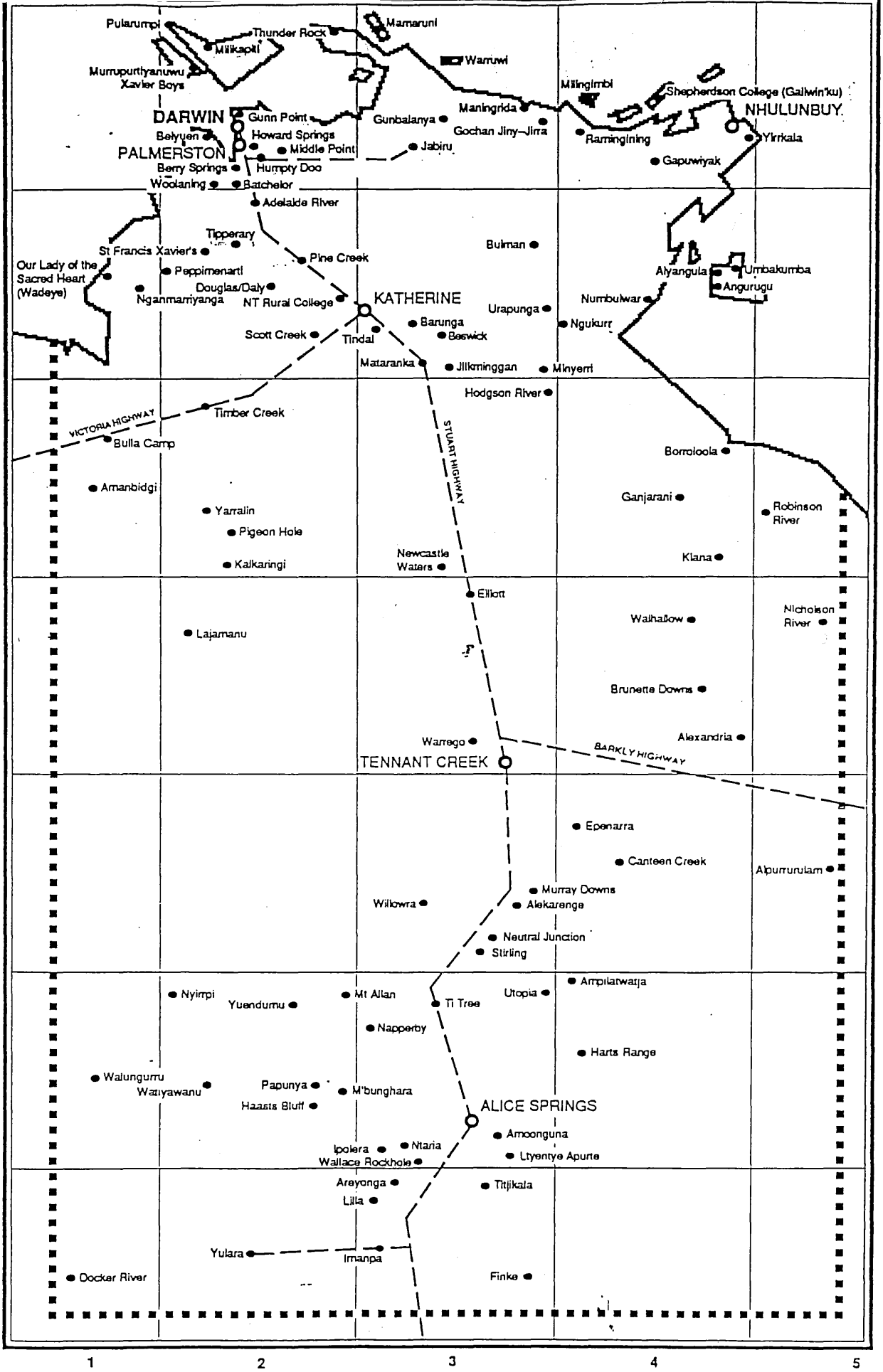


*Figure 2:* Location of Northern Territory Schools (Northern Territory Department of Education, 1994, p. 37)

## Parameters of the Discussion

The literature review, Chapters 2 and 3, begins with a brief discussion of the evolution of teacher professional development in Australia. The failure of past approaches to effect long-term change is discussed with reference to the nature of change in education. Acknowledgment of the phenomenology of change is evident in the outline of recent trends in professional development and the identification of factors which facilitate participation that is deemed by teachers to be successful for them.

The discussion on professional development continues with a shift in emphasis from the general to the specific. By way of background to the specific focus of the research there is a brief orientation to early childhood education in Australia. It is contended that, while the rhetoric of exemplary early childhood education has, to a limited extent, permeated school settings, there are contradictions in the practice of many early childhood professionals. It is suggested that there are characteristics of the culture of the school setting which create difficulties for early childhood teachers attempting to initiate change and to maintain what they perceive to be "an early childhood approach." There are, however, additional problems for early childhood teachers working to change their practices in mathematics education.

Mathematics education is first considered in terms of its importance in the curriculum of Australian schools. This is followed by a summary of recent changes in mathematics education and their potential impact on teachers, particularly those working with young children. Early childhood teachers, in the opinion of many writers, need to reconsider their roles in relation to their mathematics teaching. To what extent is the need to create a new mathematics teaching persona peculiar to early childhood teachers, and indeed, to mathematics teaching? To what extent are the problems of

teaching mathematics problems of teaching in general? The search for some answers to the problems of teaching and how teachers might reconceptualise their role leads to the identification of some characteristics of successful mathematics teaching. There is a suggestion that building on existing professional strengths may assist teachers to achieve greater expertise. Enhancing teachers' professional growth in mathematics education should be possible if a range of appropriate professional development options, such as those described in the final section of the literature review, is available to teachers.

For several decades the need to improve the quality of mathematics teaching in Australian schools has been recognised by individuals and groups operating outside and inside school settings. Many reform attempts, however, have been initiated from outside schools, principally driven by political imperatives. Sharpe, Lounsbery and Templin (1997) contended that the reforms of the past failed for a variety of reasons and have been replaced with reform attempts which have emerged from within schools. School-based reforms can be extremely cost-efficient, relevant and may be longer lasting than large-scale programs. As well, they meet the professional development needs of individual teachers. This is crucial, given that, increasingly, the responsibility for professional development will rest with teachers themselves. Professional development providers, therefore, should be aware of teachers' own perceptions of their concerns and needs in relation to mathematics education. Such is the focus of this study.

## The Research Process

The aim of this study was to describe, in depth, one component of the professional lives of teachers. Consequently the choice of data collection

tools was guided by the need to obtain rich, descriptive data which would provide support for, or discount, the views of professional development found in relevant literature. Document analysis, interviews and a questionnaire were the data collection methods chosen. Although the methods employed are frequently found in quantitative research, in this study they were designed to elicit open-ended responses and to yield qualitative data. A justification for the methods chosen is contained in Chapter 4 which places this study in a broader ethnographic tradition.

The data presented in this thesis were collected in the Northern Territory in 1994. The participants in the study were principally early childhood teachers in both government and non-government schools. In addition, several individuals involved in the planning and provision of professional development were included in the interviewing component of the data collection. Further data were collected from documents held by relevant organisations such as the Northern Territory Department of Education and the Mathematics Teachers' Association of the Northern Territory. A review of the scope and effectiveness of the data collection methods employed is contained in Chapter 8.

### Dissection of the Data: Dilemmas and Themes

Given the choice and construction of the methodology a framework for the analysis of the data was not determined prior to its collection. Decisions related to the major categories used for analysis were made after initial examination of the data. The work of other researchers provided a suitable base for drawing out major themes. The results of the research are discussed in Chapters 5 and 6 beginning with background information related to mathematics education professional development in the Northern Territory. This section of the discussion of results was based on

material obtained from analysis of relevant documents. The major section of the results, that is, data drawn from the teacher questionnaire, begins with a focus on the backgrounds and experiences of early childhood teachers including formal tertiary study, and both formal and informal professional development experiences. The questionnaire also yielded data related to teachers' perceptions of their mathematics teaching and of professional development.

The data obtained from interviews conducted with teachers and key informants have been presented in summary form in Chapter 6. The material contained in the teacher interviews provided further insights into early childhood teachers' views on teaching mathematics and on mathematics education professional development. The analysis of data highlighted some dilemmas and recurring themes related to teachers' work. The issues, themes and dilemmas which emerged from the results has been examined in greater depth in Chapter 7.

**The Research in Retrospect**

The data collected in this study did provide support for some well-established beliefs about the nature of teaching and teacher professional development. It also, however, brought to the foreground some festering work-related sores which continue to affect the professional wellbeing of teachers and threaten their capacity for effective growth and development. The discussion in Chapter 7 highlights a number of dilemmas which early childhood teachers continue to confront in their work. It is suggested that the resolution of these may influence the potential for future change and improvement in the teaching of mathematics in early childhood classrooms.

## Moving Forward in Professional Development

The foundation for this thesis was based on the premise that professionals involved in working with preservice and inservice teachers should know more about how early childhood teachers approach their mathematics teaching, and why they adopt these approaches. The rationale for this suggestion was that if greater consideration was given to teachers' own perspectives of their teaching and learning it may be possible to refine the planning and delivery of professional development programs so that ultimately the quality of children's mathematics experiences might be enhanced.

Consequently, the outcomes of this study were not disappointing. The data collected provided new insights into the work of early childhood teachers. These could well inform the work of preservice and inservice educators. In addition, the study enabled the formulation of a number of recommendations for further research which could assist in supporting early childhood teachers in their professional development endeavours. As the following chapters indicate, the professional development process is not a one-off or linear experience. The reality of educational change, at a personal or system-wide level, is that it is a complex and dynamic process influenced by a diverse range of factors. The central finding of this study is that, in order to understand how to facilitate professional development which might effect long-term change in teaching behaviour, one must respond to the contexts and backgrounds of individual teachers.

# CHAPTER 2

# LITERATURE REVIEW: PART 1

## Professional Development of Teachers

*The Australian Context*

In the past two decades there has been increased interest in the professional lives of Australia's teachers. Major reports released in Australia (Auchmuty, 1980; Commonwealth Schools Commission & Commonwealth Tertiary Education Commission, 1986; Coulter & Ingvarson, 1985; Dawkins, 1988; Department of Employment, Education and Training [DEET], 1988, 1989; National Board of Employment, Education and Training [NBEET], 1992; Schools Council, 1989) and overseas (Cockcroft, 1982; Department of Education and Science, 1988; National Commission on Excellence in Teacher Education, 1983; Organisation for Economic Co-operation and Development [OECD], 1989; The Holmes Group, 1986) have identified the need to examine and change aspects of the teaching profession including the provision of preservice education, the further education of teachers, the coordination of teacher education activities, accreditation, and teaching in particular curriculum areas, such as mathematics and science. A major focus of these reports has been recognition of the need to acknowledge and respond to the changing face of teaching. Associated with a requirement to respond to changes in education and training has been a concern with quality and attempts to imbue it with real meaning. An important element of the discussion of quality in relation to education is the emphasis placed on the relationships between appraisal, professional development and the career development of all teachers (NBEET, 1992).

The teaching workforce in Australia is ageing (Beazley, 1993; Burke, 1989; Schools Council, 1990) and is not expanding (Commonwealth Schools

Commission & Commonwealth Tertiary Education Commission, 1986). Promotion opportunities have decreased and teaching staff are relatively immobile (Hughes, 1987). Most teachers are in mid-career and the typical teacher, who is now over forty years old, has seen a major transformation in schooling in the last twenty years (Beazley, 1993). Australian schools of the 1990s are fundamentally different from those in which many teachers began their teaching careers (Schools Council, 1990). One of many changes has been a shift from centrally-mandated curriculum decisions to school-based decision making and more recently, to national curriculum profiles.

There are some similarities between Australian education in the 1990s and that of North America and the United Kingdom. One common feature of current trends in education in the countries mentioned is recent intensification and restructuring. Intensification, as defined by Fullan (1991) includes the mandating of texts and curricula, standardised evaluation measures, and the specification of teaching and administrative methods. Restructuring has resulted in shifts in the organisational units within education systems and changes in the expectations of schools and teachers. For example, increased participation rates in secondary education have meant changes in curriculum and teaching practice so that the aspirations of all young people are valued. In addition, in discipline areas such as mathematics, science and the social sciences, the knowledge base has grown and changed significantly in the past decade. The challenges facing today's teachers are daunting.

Reforms in education are affecting the profession. Stress and burnout are common and morale is low because of a decrease in the status of teaching and increased public attacks on the teaching profession (Schools Council, 1990). There is greater diversity in the student population (French, 1997; Schools Council, 1990). New priority areas and curricula changes have emerged and traditional curriculum offerings have been subject to review as

knowledge about how children learn increases (Fullan & Hargreaves, 1991; Schools Council, 1990). These and other influences have placed increased demands on teachers (DEET, 1989; French, 1997; Fry, 1987; Schools Council, 1990). In addition, the impact of rapid social, economic, and technological change is contributing to a burgeoning need for activities and programs that can assist teachers to successfully manage their contemporary professional lives. At least three quarters of those who will be teaching in our schools in the year 2000 are already in the profession and their professional needs require specific attention (Beazley, 1993).

In order to meet the existing and emerging needs of schools and individual teachers, the issue of professional support needs to be tackled in innovative ways. Reports published over the past two decades (see, for example, Auchmuty, 1980; Commonwealth Schools Commission & Commonwealth Tertiary Education Commission, 1986; National Board of Employment, Education and Training, 1992; Schools Council, 1989) highlight the need to examine the career profiles of teachers and to establish programs designed to cater for their professional needs at various points in their careers. Since the mid-1980s relatively few Australian teacher education students have been able to secure permanent teaching appointments upon graduation (Burke, 1989), so the thrust of current and future teacher support programs may need to be directed at teachers who have been in the workforce for some time. Deer (1987) claimed that this has been reflected in the literature of teacher education which, since about the mid-seventies, has shifted its focus from preservice to inservice education. During their working lives many experienced teachers have been involved in formal and informal professional development activities but the extent to which these have influenced substantial and long-term change varies significantly. Holly and McLoughlin (1989) claimed that preservice and continuing teacher education have changed relatively little over the last

several decades. They argued that future professional support programs should, therefore, combine the successful elements of past practice with new knowledge of the professional development requirements of teachers.

*Defining Professional Development*

Contrary to Holly and McLoughlin's (1989) claim that continuing teacher education has changed little in recent times there are writers who consider that views of teacher professional development have broadened. The predominant 1960s and early 1970s model of professional involvement for teachers was one of formal preservice and inservice education. This view has been subsumed by an expanded view, not yet widely reflected in the programs of many Australian tertiary institutions, which considers the total professional life of the individual (Huberman, 1993a). A perception of preservice teacher education as a "one-off inoculation against further learning" has been prevalent in the profession from time to time according to Gammage (1995). A view of teacher education which has continuing, career-long significance has a relatively short history, really becoming a major emphasis only in the past fifteen years (Hughes, 1987). It is now recognised that the education of teachers, like the education of members of all professions, should be considered as a continuum from initial formal preservice training and experience through all aspects of professional development and further study (Maling, 1984; Mathematical Association of Victoria, 1989).

In literature related to the professional lives of teachers a number of terms are used, often interchangeably. Among these are staff development, professional renewal, inservice, recurrent education and professional development. One of the frequently used labels for teacher professional development is inservice, which now has a wider definition than would have been ascribed to it by teachers a decade ago. Until the 1980s, inservice

education for teachers was assumed to encompass mainly award and non-award courses for teachers at system or regional level, or in tertiary institutions (Beare & Van Raay, 1982). More recently it has been described (Boomer, 1987; Coulter & Ingvarson, 1985; DEET, 1988; Docker, 1987) as any activity, usually deliberate and formalised, whereby those working in education, beyond preservice years, may in some way upgrade their understanding, skills or attitudes in relation to their profession. Inservice activities may be initiated by teachers themselves, by their employers, by tertiary institutions, or by other agencies with a stake in education, and they usually have as their purpose the improvement of the educational enterprise, particularly the quality of teaching, and, in the final analysis, better outcomes for students (DEET, 1988).

Professional development is, in general, used as a more all-encompassing term than inservice. The Commonwealth Schools Commission, at its inception in 1973, defined professional development as all the planned experiences which qualified teachers may undergo for the purpose of extending their professional competence (Hughes, 1987). In the Schools Council (1989) report on *Teacher Quality*, the professional development of teachers is viewed as a continuum, commencing at preservice, moving through entry and induction, and continuing with regular in-servicing throughout a teacher's career. Professional development aims to increase teachers' knowledge of, understanding of, and expertise in, their professional work through participation in professionally relevant activities (Docker, 1987). Professional development is, according to French (1997), more than training in new knowledge or instructional procedures. Meetings, workshops, visits, networks, and professional reading programs, including reviews of curriculum documents, are examples of activities which may be incorporated in professional development programs (Harisun, 1987; Richards, 1986). High

quality professional development enables teachers to grow professionally and to move beyond their current level of expertise and ability (French, 1997). There is, however, a bias evident, in the examples cited, towards formal or planned activities. For the purpose of discussion in this study, the definition of professional development to be adopted will be that of the Schools Council (1989) which stated

> Professional development is a continuum, commencing at preservice, moving through entry and induction and continuing with regular in-servicing throughout the teacher's career. The professional development of a teacher will be effected through all the experiences undertaken by the teacher, whether in or out of school time, whether formal or informal, whether deliberately an adult learning activity or not. (p. 2)

The acceptance of this broader definition of professional development means that account needs to be taken of teachers' personal, intellectual, emotional and social development when discussing their professional lives.

### Traditional Approaches to Professional Development

Implicit in the statement that changes to teacher professional development are timely is a belief that the practices of the past have not always been successful. This is clearly articulated in the Commonwealth Schools Commission and Commonwealth Tertiary Education Commission (1986) report *Improving Teacher Education* which, following a review of reports on teacher education, stated

> An issue which has not been included in the review reports, and is considered critical to the development of a national approach, is the promotion of more effective practices in inservice education. While most teachers, administrators, and parents involved in educational planning are convinced of the value of inservice education there is considerable questioning of the ability of current practices to bring about effective change and improvement in student outcomes from schooling. (p. 38)

It would appear that past professional development practices warrant scrutiny to ascertain which components should be retained because of their perceived value in relation to meeting the future professional needs of teachers.

Craft (1996) summarised the major weaknesses in the course-led model of professional development and concluded that the following factors contributed to its failure to engender meaningful, long-term change.

- Domination of off-site courses, geared to individuals rather than groups of teachers.
- No linkages to the needs of departments or schools.
- Courses are undertaken on a voluntary basis and, therefore, not necessarily undertaken by those with the greatest need.
- Courses are random in terms of participation and content in relations to the needs of individual schools.
- It has limited impact on practice with little or no dissemination or follow-up.
- Courses are often undertaken during the school day and therefore disrupt the teaching timetable.
- It is open to a possible conflict between participant teachers as theorists and deliverers.
- It attempts to cater for people at different starting points and, therefore is unable to satisfy all participants equally well. (p. 8)

Cranton (1996) described similar factors and claimed that professional preparation bodies were grounded on a model of education which separated learning from doing, and this way of thinking was carried through into professional development experiences as well.

The traditional organisation of teacher professional development, according to several writers (see. for example, Bolam, 1982; French, 1997; Lieberman, 1995; Sharpe et al., 1997), was based on a model of inservice activity whereby teachers were withdrawn from their schools to undergo training and then returned to their schools. This practice of bringing teachers out of school, giving them the "good oil," then sending them back again—that is, a "deficit model" of inservice—has not proved to be an effective vehicle for bringing about lasting change. The notion of

encouraging teachers to leave their workplaces to participate in professional development was, in itself, not necessarily inappropriate. What did make the "deficit model" approach largely ineffective was that it assumed a stance towards practice that concentrated on prescription (Ball, 1996; Butt, Raymond, McCue & Yamagishi, 1992) and viewed teachers as technical implementers of knowledge about effective teaching often generated by university-based researchers (Sharpe et al., 1997). The result has been an emphasis on answers and the formation of bodies of professional knowledge which have been largely ignored by professionals in action since they have found that little of such prescriptive technology is appropriate to specific situations whose nature is uniquely personal, instinctive, intuitive, reflective and practical.

Tom (1987) and Weikart (1994) claimed that the "deficit model" approach to professional development implies a view of teaching as a craft and a belief that the essence of teaching is found in the "how to" knowledge that teachers have accumulated over the years and have occasionally codified. The "deficit" or "teaching-as-a-craft" model may be an expedient means of meeting the needs of the education system at its various levels but it ignores the differential impact of positive and negative factors within the schools to which the teachers must return and operate (Bolam, 1982; DEET, 1988). Criticisms of this approach have been based on the assumptions which are made of the teacher as a learner, the motivation for participation, the location and content of the activities, their relevance to classroom practice and the degree of preliminary and post-activity support. The model described above also ignored, according to several writers (see, for example, Ball, 1996; Lieberman, 1995; Sykes, 1996), the constraints under which teachers work. Contextual factors such as parental resistance to change, or intolerance by administrators of less orderly classrooms, may impede progress towards teaching for understanding.

Lieberman (1995) and Postle and Logan (1987) stated that the dominant paradigm in inservice education is conformist, and teachers are viewed as implementers of prescriptive, centrally-developed curriculum programs. Further, they asserted that teachers are considered to be on the whole unwilling to experiment or innovate, and are perceived as more "other-directed" than "self-directed." There was also a belief that educators in inservice are just like educators in preservice (Arends, Hersh & Turner, 1978). Both teachers and their employers, Mousley (1992) reported, have increasingly recognised the fact that traditionally passive roles in inservice courses do little to develop interpersonal skills and attitudes appropriate to the complex and shifting relationships within schools. Teacher attitudes and beliefs have been cited by Hyde (1989) and Lubinski (1994) as two of the most important influences on teacher behaviour.

In the past consideration has not always been given to the needs of teachers as adult learners (Jones, 1993; Robinson, 1989). Consultancy and advisory staff are often selected from successful classroom practitioners who may not necessarily be able to communicate effectively with adults. Robinson (1989) claimed that sometimes those involved in consultancy or professional development see themselves as evangelists, bringing the "good news" to the waiting masses. Fullan (1982) claimed that those who introduce change (policy makers, university staff, administrators, professional development presenters) treat teachers in precisely the same way as they criticise teachers for treating the students. Fullan (1982) went on to say that new curricula emphasise the importance of being sensitive to where students are, what they think and why; but these curricula are often introduced in a way which ignores what teachers think, and why. Inservice programs have rarely addressed the direct needs and concerns of individual participants (DEET, 1988; Johnson, 1990) and have not varied according to

the teachers' years of service, the locations of their schools or the grade level taught.

Not only has inservice education failed to consider the teacher as individual professional identity but there has also been a failure to link personal development with professional development, and to address the teacher as a person with a physical, emotional, intellectual and spiritual life to be nurtured (Cahill, 1986). Attempts to influence change in teachers, some authors have claimed (see, for example, Collinson, 1996; Haberman, 1989; Lawn, 1989), have tended to focus on improved pedagogy and more subject matter rather than teacher growth. Haberman went on to say that if teachers were better people, more humane, with greater understanding, more reflective, more sensitive, more empathetic, and more fully self-actualised then they would inevitably be better teachers.

Bell and Gilbert (1997) described the interaction of professional (cognitive and action development), personal and social development and reported that all were evident when teachers engaged in development activities. Coulter and Ingvarson (1985) argued that a basic principle of inservice education is that it is a vehicle for enhancing the autonomy and professional self-esteem of teachers as well as a means of improving the level of teaching skill and competence. Several writers (see. for example, Clemson & Clemson, 1994; Craft, 1996; Dean, 1991; Jones, 1993; Katz, 1995) have emphasised the importance of providing choices as a way of encouraging autonomy and self-esteem. These authors have mentioned that exposure to a wide range of professional development options may encourage greater participation. As the discussion of appropriate modes of contemporary professional development evolves there will be further recognition of the importance of the issue of teachers as adult learners.

Cahill (1986), in a study of professional development in the United States of America, found that the main motivation for teachers to become

part of a career-long self-education process through involvement in development programs was generally associated with considerations of money, status and power, with little or no consideration given to the importance of social satisfaction, awareness of growing competence, or the sense of becoming self-actualised. Examples of professional development being motivated by status, money and power were evident in Australia in the 1970s when many two-year trained teachers upgraded their qualifications so that they would be placed on higher salary scales or were likely to enhance their chances of promotion. Such motivations are less likely to apply in the diminished Australian teacher employment market of the 1990s. Glatthorn and Fox (1996) claimed that teachers vary considerably in their motivation. They reported that research showed that the factors which influenced motivation were a supportive environment for quality teaching, meaningful work, belief systems, goals, rewards, feedback and autonomy and power. Eraut (1993) suggested that teachers may also be motivated by a perceived need to improve their practice or to redirect their goals. The latter aspect of motivation would seem significant in the current Australian climate of regular curriculum revision and increased accountability.

A focus solely on the teacher as the one responsible for improving instruction means that insufficient attention is paid to organisational and social factors and to matters such as advisory and consultancy support, teacher relief in schools, and the role of school communities (Lieberman, 1995). Little importance has been placed on social interactions as a source of personal and professional maturation (Anderson, 1996). Teachers, according to Cahill (1986) and French (1997), are often viewed as isolated individuals operating in a particular classroom with a particular group of students, with little or no contact with other members of staff. These writers also claimed that the school has been presented as many classrooms which happen to be

adjacent. Fullan and Hargreaves (1991) and Lieberman (1995) believed that there is simply not enough opportunity, and not enough encouragement, for teachers to work together, learn from each other, and improve their expertise as a community. Central to a theory of constructed knowledge, Collinson (1996) contended, is social interaction—the need to learn with others to see various approaches and alternatives to solutions, the idea of experts or "coaches" helping novices, and the belief that working together can help individuals extend their knowledge beyond what would have been possible alone.

In the past, inservice providers packaged programs believed to be responsive to teachers' needs. Thus the participating teachers often perceived inservice activities as a way of correcting a deficit rather than as a means for giving teachers the opportunity to participate in experiences which had the potential to enhance professional growth and skill development (Arends et al., 1978). It is now recognised that deficit inservice models may not cater for the needs of specific schools or individuals (Alexopoulos, 1986; Arends et al., 1978; Lieberman, 1995). In addition to lowered self-esteem engendered by the identification of assumed deficits in their practice, teachers are often further daunted by the presentation of new ideas by enthusiasts so that the innovations appear to be the only concerns any teacher could or should have, and which may be unrelated to any other teaching undertaken (Davis, 1987).

Robinson and Alexopoulos (1987) pointed out that the presentation of new curriculum statements and other documents exhorting teachers to change makes little difference to what occurs in schools. Schools and teachers are bombarded with new ideas and must sift through and select from many competing ideas for change (Sykes, 1996). Classroom-relevant content and easily adaptable teaching and instructional methods are infrequently presented in inservice courses, and the content chosen by

inservice providers may not be connected to the priorities of schools (Commonwealth Schools Commission & Commonwealth Tertiary Education Commission, 1986; DEET, 1988). Inservice activity, as with classroom teaching, has a tendency to be organised for the convenience of the organisers rather than that of the participants (Boomer, 1987).

From a psychological viewpoint inservice programs, in terms both of their implementation and of the approach they espouse, have strongly favoured psychoanalytic and behaviourist theories, with little or no reference being made to what might be broadly termed as humanistic-existentialist understandings (Cahill, 1986). The approaches used with teachers have generally not favoured interactive or constructivist learning ideas. There is no overt recognition of an approach which views the student, or the teacher as learner, as potentially a fully functioning human person (Cahill, 1986).

Cahill (1986) and Blackman (1989) felt that there has been little stress on the importance of relationships at inservice programs, and that the fostering of good relationships is for the well-being of the teacher, for mutually beneficial interactions between teacher and student, and for the class to become a cohesive group. Blackman (1989) claimed that those with whom teachers are able to (and choose to) communicate with is likely to have a professional influence on their personal identities as teachers. Cahill (1986) continued by suggesting that training in interpersonal skills and the theories and practice related to group structure, group dynamics and group processes have not been prominent features of inservice programs. Participants, and those who conduct teacher professional development activities, could benefit from assistance in developing interpersonal communication skills.

Bell and Day (1991) stated that the development of teachers has been haphazard and much of what was learned as teachers came from day-to-day interactions with colleagues. They warned that this is a limited and

insufficient form of development and that there are serious flaws in this approach to career development. For example, the role models adopted may be inappropriate to follow or the staff team may not be united or effective. Further, the experience that a particular member of staff may need in order to update skills or knowledge may not be present in the school. There is also the concern that a passive approach to staff development by which staff learn solely by association with colleagues is not consistent with the need to manage schools in a coherent, planned, and structured way. More recent writing (see, for example, Anderson, 1996; Crowther & Gaffney, 1993; Lieberman, 1995) has highlighted the importance of networks, collaboration and partnerships as a way of providing teachers with professional learning communities which support changes in teaching practice. French (1997) and Jalongo (1991) asserted that teachers lack most of the support mechanisms available in other workplaces. Teachers are unable, for example, to lean over to ask the help of a worker at the next desk. In addition, French argued, opportunities to observe peers or to work together are limited. At best, teachers can seek support from colleagues at the end of the day, long after the need for assistance has passed.

Reports of earlier professional development activities indicate that there has been little continuity and coordination between or among school staff development and inservice activities. Many inservice activities have taken the form of isolated seminars or conferences, without follow-through and recall (DEET, 1988). In the 1980s funding for support services such as curriculum consultants and advisers decreased with the result that individual teachers, struggling to trial new ideas and materials, have had little support from the agencies which initiated curriculum or policy changes.

Teachers, in their comments to inservice organisers, have questioned the effectiveness of many activities (Fullan, 1982). Because of their position

in the hierarchy, inservice providers are often programmatically isolated and politically weak. Teachers know where the real power lies. There is often an attitude among teachers that those who run inservice programs seldom run schools or know a great deal about schools or about what is expected in such institutions. Inservice presenters have not only faced problems of credibility but many have also been unable to meet the demands of working with adult learners with a range of backgrounds and learning styles. Overcoming such difficulties is one of the challenges for educators involved in the design of professional development programs.

## Emerging Trends in Professional Development

Auchmuty (1980) predicted an increased interest in teacher professional development and stated that it would become the major means of safeguarding and further improving the effectiveness of the teaching force, and thus the quality of learning, in Australian schools. He recognised that preservice courses could not cover all the elements relating to a teacher's work and that there should be an acceptance of lifelong learning as a basic principle since rapid expansion of knowledge has become a characteristic of all professions. This view of teacher education as a continuum of ongoing professional development is supported by several writers (Beeson, 1987; Collinson, 1996; Coulter & Ingvarson, 1985; Hughes, 1987; Meade, 1987). A model which accommodates the notion of lifelong learning would necessarily be flexible and have sufficient vision to cater for a diverse group with ever-widening needs and responsibilities.

Jalongo (1991) stated that there are a number of key issues which need to be addressed in relation to teacher professional development. These are:

- responsibility for professional development;
- the concept of professionalism;

- the uniqueness of the teaching profession;
- sources of professional authority;
- elements of teacher professionalism;
- role clarity;
- autonomous functioning; and
- interactive decision making.

The interaction of these factors contributes to the success, or failure, of professional development activities. The challenge for professional development providers and planners is to secure an appropriate balance in emphasis between these factors.

The providers of professional development activities have been alerted to the need to pay attention to the characteristics of mature professionals in their planning (Arends et al., 1978; Ball, 1996; Boomer, 1987; Collinson, 1996; Wadlington, 1995). Adult learning theory, as discussed by Boomer (1987), incorporates the need to allow adults to test new information or ideas in practice and to have the opportunity to plan and control their own learning. In addition, Boomer felt that adult learners needed to have opportunities for demonstration, observation, and questioning. These opportunities should occur in an environment which takes account of differences in preferred learning styles and rates of professional growth. Boomer suggested that adult learning theory also enables participants in professional development to evaluate the effects of their actions, discuss new information and ideas with their peers and tutors and to link new information with present knowledge. Ball (1996) argued that even when participants "share" ideas the potential for critical discussion may be limited because professional development leaders, seeking to make participants comfortable, rarely challenge teachers' assumptions or intentionally provoke conflict. This may be, according to Butt et al. (1992), because professional development interventions have been based on less than

adequate, if any, conceptions of how learning occurs throughout teachers' careers. The apparent lack of understanding of adult learning has been addressed in recent work such as that of Glatthorn and Fox (1996) whose synthesis of research on adult learning is presented in Table 1.

Wadlington (1995) suggested that too often teachers themselves do not view their own learning as a lifelong process requiring critical thinking, reflection and self-direction. She recommended that four basic principles of adult education theory be considered when working with teachers. The principles described are:

1. The self-concept of an adult is one of an independent, self-directed human being.
2. Adults have an extensive bank of experiences that may be used as a learning resource.
3. Adults' readiness to learn is closely related to the developmental tasks of their social roles.
4. The adult's perspective on learning is one of immediate application rather than on future application. (p. 76)

Wadlington argued that one of the implications of adopting the principles outlined above for teacher professional development included establishing a learning climate of respectful collaboration, tolerance, and free expression.

Poelle (1993) asserted that increased attention to the needs of adult learners must also be balanced by recognition of the need to adequately prepare teachers of adults in adequate and appropriate ways. Many teachers, according to Poelle and other authors (see, for example, Acquarelli & Mumme, 1996), do not possess skills in significant areas such as team-teaching, resolving conflicts and leadership. Developing confidence in their ability to lead a team of peers may be an additional professional development challenge for some teachers.

Attention to the needs of teachers as adult learners has had implications for various dimensions of professional development programs. If planners and organisers allow time, during the implementation of programs for

Table 1

*How Adults Learn: A Synthesis of the Research*

(from Glatthorn & Fox, (1996).

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*Structure of Learning Experiences*

1. Prefer flexible schedules that respond to and take cognizance of their own time pressures
2. Learn better when learning is individualised—when they can pace their own learning, identify their own learning needs, and select their own learning experiences
3. Prefer face-to-face learning in classes, internships, and workshops; are less interested in audio and video cassettes and independent study
4. Derive benefit from heterogeneous classes in which they can interact with adults of different ages and with contrary views

*Learning Climate*

5. Seem to learn better in a climate characterised by mutual helpfulness and peer support
6. Are somewhat reluctant to take risks and therefore do better in a climate that is characterised by a sense of trust and acceptance of differences
7. Appreciate the opportunity to express views and are open to learning from those holding contrary views
8. Come to classes and workshops with clear expectations and hope that instructor will take their expectations into account in his or her planning for learning

*Focus of Learning*

9. Seem to derive the greatest benefit from teaching that helps them process their experience through reflection, analysis, and critical examination
10. Value learning that increases their autonomy and helps them create personal meaning
11. Interested in practical "how-to" learning that they can apply to immediate career-related issues

*Teaching-Learning Strategies and Media*

12. Value problem solving, cooperative learning
13. Desire active participation in the learning process, with constructive feedback; reluctant to sit through long lectures. (p.7)

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for discussion and reflection, then the time framework for programs changes. Cahill (1986) claimed that there is a trend towards the placement of single professional development activities within long-term plans which have been derived after consultation with potential participants. Cahill (1986) also reported that there are less top-down and "one-shot" isolated activities, and more in which participants are involved in planning. The planning includes selecting appropriate modes of presentation, building in requirements for prior preparation, post-activity discussion and reflection, and determining target audiences for programs. In general, there is now a greater degree of personal involvement by teachers in professional development programs. Prawat (1992) claimed that such reforms mirror those occurring in the private sector where there is now an established relationship between worker autonomy and control. The advantages of embedding professional development experiences within a broader context of school-based and classroom-based practice are discussed in greater depth later when consideration is given to the ideal conditions for fostering successful professional development.

Clarke and Peter (1993) suggested that the role for inservice activity is to inform and stimulate the experimentation which is a part of most teachers' practice. Classroom experimentation should be seen as the contextual catalyst for professional growth and the outward evidence of teacher change. Exemplary models of professional development allow teachers to critically examine their own classroom performance in a critical manner and to discover ways to improve (French, 1997). According to Levine (1989) there are several keys to selecting individual and group supports which enhance adult development. Characteristics of activities must capitalise on one or more of the conditions known to support and promote growth. Independent study, for example, exploits the adult learner's increasing capacity for independence. Mentor programs address the young adult's need

for guidance and the middle-aged learner's desire to nurture. Support groups, coaching, and professional development organisations all take advantage of an adult's need for peer interaction and interdependence. Craft (1996) warned, however, of the need to ensure that both school and individual needs are addressed through professional development activities.

Some of the needs of practising teachers relate to groups of teachers as clients in the education system. As mentioned previously, the organisation of professional development programs by personnel isolated from the teaching workforce was a major factor in the past failure of many inservice activities. The involvement of teachers in the planning of their own professional development has contributed to one of the major changes in the provision of teacher professional development in the past two decades: the shift from external to school-based activity. This is in keeping with recent education policies which have focused on the school. The identification of goals, curriculum content and evaluation strategies by personnel from a particular school is often labelled school-based curriculum development.

Andrews (1988) identified the four key features of school-based curriculum development as (a) system-initiated but school-based in its application; (b) the induction of key school personnel; (c) the development of school policy and curriculum statements; and (d) the provision of system level support services. The new and positive dimensions of such programs are that the priorities of the school are considered and that professional development occurs within a supportive organisational climate which encourages commitment. Neal (1987a) commented that, not only should professional development activities take place in the school, but they should be cooperatively planned so that system, school, and individual needs are met. Prideaux (1993) challenged the claim that school-based curriculum

development was a "grass roots activity" and that it was characterised by a genuine shift in the locus of control of curriculum. Prideaux suggested that the tenets of school-based curriculum, as introduced in the 1970s, may not be appropriate in the changed educational climate of the 1990s. He also argued that the deconstruction of curriculum development and an examination of the power relationships in education could become useful directions for the activities of teachers and other curriculum workers. Craft (1996) warned that one of the drawbacks of school-based professional development is that it can become rather insular.

A more recent coverage of issues related to school-based reform is that of the National Board of Employment, Education and Training (1994) which situates the teacher learning which occurs in schools within a broader framework of workplace learning. NBEET acknowledged the concept of the school as an educative workplace/learning community which should be made a more explicit feature of education system restructuring efforts and school reform. Among the recommendations contained within its document *Workplace Learning in the Professional Development of Teachers* NBEET recommended that a model of workplace learning should be used as a framework for rethinking not only inservice teacher education but also the roles and relationships in preservice field experiences. Such an emphasis acknowledges acceptance of the notion of professional development as a lifelong enterprise.

*Whose Responsibility is Professional Development?*

Many large-scale professional development activities initiated by education systems and aimed to meet their needs have been replaced by school-based activities directed at meeting school and individual needs. Thus the organisation of professional development activities is now seen as a joint responsibility of governments, employing authorities, the profession

itself, and individual teachers (Beeson, 1987). In their study of teacher professional development in Australia, Coulter and Ingvarson (1985) noted that employers and state inservice committees considered that the individual teacher had a responsibility to maintain a commitment to learning as a lifelong process, including reflection and self-evaluation on the quality of teaching. Several authors (see, for example, Collinson, 1996; Duckworth, 1987; Duff, Brown & Van Scoy, 1995) have contended that the ways in which teachers model their disposition toward continuous learning and critical reflection profoundly affect what students ultimately think and know. Ball (1996) and Greenough (1993) concurred that reflection is seen as central to learning to teach but argued that more attention needed to be given to the specific objectives and nature of reflection. Mezirow (1991) distinguished between content, process and premise reflection and suggested that each invites different responses to problems encountered in teaching. Cranton (1996) suggested that questions generated from the types of reflection described by Mezirow be tackled with specific strategies such as articulating assumptions, determining sources and consequences of assumptions, critical questioning and imagining alternatives. Korthagen (1993) and Hart, Schultz, Najee-ullah and Nash (1992) agreed that the ability for reflective teaching and subsequent action can help teachers to retain interest in their work and to maintain a reasonable level of job satisfaction.

Fry (1987) supported the view that teachers, as professionals, should be responsible for their own continuing professional development as they seek to address emerging needs and challenges in their professional roles. He compared and contrasted current approaches to the professional development of teachers with the way in which doctors and mechanics are exposed to new ideas in their fields. A new development in the car industry, for example, such as fuel injection, is likely to be communicated to mechanics via a workshop at which training in the new techniques would

be given and after which participants would receive some certification. By way of contrast, a new idea in medicine, such as LASER treatment, would be communicated to doctors through journals and seminars, and doctors would choose whether or not to introduce the new idea. If teachers are to claim their right to professional status then the medical approach to professional development may serve as a good model. Many current inservice activities, however, utilise the motor industry approach to acquisition of new knowledge—change is imposed upon everyone at the same time, in the same way, whether it is needed or not. The medical model relies on the professional to maintain a high level of personal education and to try new approaches and materials. The degree to which this happens is variable. Glascott (1994) has argued that doctors do not walk into surgery with an instruction manual but interpret cases individually, and then apply the most appropriate interventions. The ability to analyse situations, identify needs within a context and apply the most effective strategies is what distinguishes a professional, according to Glascott. Doctors, lawyers and engineers have systems of advanced certification and workplaces which foster opportunities for continued growth but, according to French (1997), teachers rarely have time in addition to their school day to keep up with the knowledge explosion and learn new ways to become more effective. Why is this so? If doctors have time for professional development why don't teachers? Is the implication that teachers, in fact, have more in common with mechanics than other professionals?

*Teaching as a Craft*

The solution of practical problems, according to Butt et al. (1992), derives more from reflection-on-action, reflection-in-action, professional intuition, craft and art and the special knowledge held by the teacher. The nature, then, of professional action, especially teaching, requires a focus

primarily and initially on the qualitative rather than quantitative nature of practice, in order to derive professional knowledge useful to both scholars and practitioners. This position is supported by Clarke and Peter (1993) who claimed that consideration must be given to four domains, the personal domain (teacher knowledge and beliefs), the domain of practice (classroom experimentation), the domain of interference (valued outcomes) and the external domain (sources of information, stimulus or support) when discussing teacher change.

Blackman (1989) proposed that the ways in which the roles of those involved in professional development are viewed has a direct influence on the outcomes of the professional development itself. If teachers are viewed as appliers of a craft, then professional development activities will focus on methods and techniques. If the teacher is viewed as operating in isolation, then there will be a focus on classroom activities. Blackman (1989) claimed that if teachers are viewed as professionals then they should be considered capable of creating their own agendas for professional development. Grimmett and Mackinnon (1992) considered that craft knowledge is understood differentially by those who subscribe to respective traditions of teaching. The conservative tradition's view of the educational process as a means of cultural transmission implies a view of craft knowledge as inherently unscientific and contributing to the mindless imitation of practice. Grimmett and Mackinnon reported that conservative views of craft knowledge did not allow teachers to transcend the "folkways of teaching" and critically question their pedagogical thinking and classroom action.

In a progressive tradition the emphasis in the educational process is on enquiry revolving around students' interests which gives rise to mastery of subject matter. In this tradition teachers learn from their practice in order to

refine their craft. The way teachers learn their craft is consistent with theories of situated practice (Liston & Zeichner, 1991; Resnick, 1991).

Craft knowledge is essentially the accumulated wisdom derived from teachers' and researchers' understandings of the meanings ascribed to the many dilemmas inherent in teaching (Grimmett & Mackinnon, 1992). An important aspect of craft knowledge in teaching is that the work context of inquiry and student learning is collaborative in the sense that teachers and students negotiate meaning and work activities together. Grimmet and Mackinnon (1992) asserted that the craft of teaching is learnt through experience. They believed that craft knowledge has an important role to play in the formation of skillful, reflective and empowered teachers. They also believed in the power of demonstration of good practice by outstanding teachers especially when such demonstration is carefully debriefed and reflectively analysed.

Teachers are now seen to have a range of responsibilities in relation to their professional development. These responsibilities include the maintenance and extension of a range of teaching skills, keeping abreast of new knowledge in a specific subject field, a willingness to participate in the planning and implementation of inservice education activities within and outside the school, and participation in the dissemination of knowledge and skills acquired at inservice courses (Coulter & Ingvarson, 1985). Although employing authorities may state that teachers are responsible for their own professional development, they cannot, however, completely relinquish a commitment to some components of professional development programs.

According to Neal (1987a) education systems should continue to take responsibility for (a) maintaining a record system which documents the professional development of each teacher; (b) requiring all teachers to participate in professional development; (c) counselling individuals on possible career paths and assisting them to develop new skills as required;

(d) viewing a teacher's career as a continuum from preservice through induction to inservice and various stages of development along the way; and (e) accepting that a weak teacher or a tired teacher often results from the failure of the system and that early diagnosis might lead to successful rehabilitation. Rawlinson and Guild-Wilson (1987) added that the education system also has a commitment to the employment of qualified staff, to induction programs, and to the planning of appropriate career and promotion structures.

Education systems, employing authorities, tertiary institutions, and professional associations have traditionally been the major providers of teacher professional development activities. Collaboration and coordination between these providers is seen to be essential if professional development programs are to achieve their desired aims. In particular, effective liaison between higher education institutions, as providers of preservice education, and schools is crucial (Beeson, 1987). This should involve not just provision of formal award courses but a commitment to joint participation in the lifelong professional development of teachers.

## The Nature of Change in Education

In order to implement a professional development program in a successful manner, planners and providers should understand the nature of educational change. Central to such an understanding is knowledge of the purpose of reform, the potential sources of educational change, the adoption of the change process, and the roles of participants in change. Fullan (1982) claimed that neglect of the phenomenology of change, that is, how people actually experience change as distinct from how it might have been intended, has been at the heart of the spectacular lack of success of most social reforms. Walley (1995) stated that despite positive intentions

and thorough planning, resistance to change is commonplace. He claimed that redefined roles and expectations naturally lead to some people feeling uncomfortable or threatened.

Print (1987) defined change as a generic term used in education to incorporate a number of associated concepts, such as innovation and adoption, in order to analyse and explain curricula phenomena. This change may be planned or unplanned. Innovation has been described (Marsh, 1986; Print, 1987) as an object, idea, or practice which is perceived to be new and also as the process by which that new object, idea or practice becomes adopted. The critical component of this definition is the perception of novelty. An inherent assumption in Print's (1987) discussion is that objects, ideas, or practices which have been introduced to one group will be innovatory to another group.

In a discussion of the meaning of change in education Fullan (1982) emphasised the need to explore all dimensions of innovations including the values involved, the beneficiaries of change, the level of priority of the innovation, how achievable change is, and areas of potential change which are being neglected. Fullan also considered that it is valuable to examine the motives for change and stated that change may come about because it is imposed, or it may be brought about by voluntary participation or initiation when dissatisfaction, inconsistency, or lack of tolerance with a current situation exists.

*How Does Change Come About?*

According to Marsh (1986) most curriculum writers agree that there are four basic phases in the process of change in education. These are (a) the orientation or needs phase when dissatisfaction, concern or need is felt and expressed by one or more individuals; (b) the initiation or adoption phase when discussion of how the change will occur takes place; (c) the

implementation or initial-use phase when new ideas or materials are trialled; and (d) the institutionalisation or continuation phase when new ideas become more firmly embedded in the permanent repertoire of the change participants. Fullan (1982) outlined a number of factors affecting the success of each of the change phases. These factors have been classified by Marsh (1988) as relating to people, the innovation and resources. Marsh (1988) included in the factors associated with the participants in change the time allocated for planning and decision-making, the degree of commitment, the involvement of key personnel, the extent to which the new program fits into teachers' existing frameworks of interests, and the nature and availability of external assistance. Print (1987) considered the crucial aspects of an innovation to be (a) its relative advantage in comparison to existing ideas, objects or practices; (b) the degree of compatibility of the innovation with past experiences and present needs; (c) the complexity of the innovation; (d) the ease with which the innovation can be trialled; and (e) the extent of the communication of the features and benefits of the innovation. Etchberger and Shaw (1992) suggested that the following five interrelated requisites are necessary for change to occur.

> 1. Perturbation. This is a dissatisfaction or uneasiness with the way things are. For example, teachers may not be happy with their present teaching methods or satisfied with their students' understandings.
> 2. Awareness. This occurs when the teacher realises that for things to improve there will have to be a change.
> 3. Commitment to change. When a teacher commits to change, he or she has made a firm decision to move beyond awareness and into action.
> 4. Vision. With the decision to change, the teacher envisions what the change actually will involve, for example, changing group sizes.
> 5. Projection into that vision. This occurs when the teacher visualises self and class becoming participants in the change.
>
> (p. 411)

The latter two prerequisites, according to some writers (see, for example, Prawat, 1992) are problematic for many teachers and are areas where appropriate support is essential.

*Why Innovations Fail*

Attempts to change education practice and attitudes sometimes fail. Hall and Oldroyd (1991) identified three types of barriers to change; technical (such as lack of resources or inadequate facilities), value (where teachers' beliefs and attitudes are opposed to the change) and power (where the head teacher is against the change or there is not a "critical mass" of staff in favour of it). According to Fullan (1982) failure can be attributed to such factors as the motives and potential career advancement of the initiator, a choice of "opportunistic" rather than "problem-solving" reform, and innovation bias by neglect (for example, an emphasis on basic skills and factual knowledge at the expense of higher order cognitive skills). Fullan commented that a high level of commitment on the part of the initiator may not always be an advantage with respect to influencing implementation by others and that, similarly, successful change by one group of teachers does not necessarily mean that other teachers can implement the same change program successfully.

Fullan (1982) stated that in implementing any new program or policy in education the components or dimensions at stake are the possible use of new or revised materials (direct instructional resources such as curriculum materials or technologies), and the possible use of new teaching approaches (that is, pedagogical assumptions and theories underlying particular new policies or programs). McNeil (1985) discussed other dimensions including (a) substitution, where one element could be exchanged for another; (b) alteration, which occurs when a change is introduced into existing material; (c) perturbations, which are irritating changes readily adjusted to in a short

time; (d) restructuring, where the system itself is modified; and (e) value orientation changes, where there are shifts in the fundamental value orientations of the participants. Substitution and alteration are most easily achieved but value orientation change should be a principal goal.

Fullan (1982) stated that in planning and implementing educational change the following assumptions should be seen as basic to a successful approach:

- Do not assume that any one version of what the change should be is the one which should or could be implemented;
- Assume that any significant innovation, if it is to result in change, requires individual implementers to work out their own meaning;
- Assume that conflict and disagreement are not only inevitable, but fundamental to successful change;
- Assume that people need pressure to change (even in directions which they desire), but that it will only be effective under conditions which allow them to react, to form their own position, to interact with other implementers, and to obtain technical assistance;
- Assume that effective change takes time;
- Do not assume that the reason for lack of implementation is the outright rejection of the values embodied in the change, or of hardcore resistance to all change;
- Do not expect all, or even most, people to change;
- Assume that a plan, based on the previous assumptions, is needed;
- Assume that no amount of knowledge will ever make it totally clear what action should be taken;
- Assume that change is a challenging, frustrating business.

(p. 91)

Embodied in these assumptions are a number of considerations which will be explored more fully in the context of professional development in mathematics education.

It would appear from reflecting upon Fullan's (1982) recommendations that it is difficult to implement change unless certain conditions exist. This view has been supported by McNeil (1985) who concluded that change is most likely to occur when one or more of the

following conditions exist (a) a prevailing social change is in the same direction as the proposed change; (b) there is an imbalance in the traditional power balance; (c) a crisis develops in a time of change; (d) administrators see change as beneficial to their own interests; and (e) a change in the physical arrangements of the institution offers the chance to rethink curriculum offerings. A further condition necessary for change described by Print (1987) is the need for teachers to relate to the various problems which emerge from the change process. Marsh (1988) identified particular areas in which teachers may need special assistance including (a) the selection and use of appropriate curriculum materials; (b) techniques for assessing, recording and reporting students' learning outcomes; (c) developing appropriate methods of evaluating a curriculum; (d) increasing their repertoire of presentation modes to students; and (e) developing decision-making, participative skills which enable them to interact with other teachers.

Clarke (1993) concluded that the factors which influenced the process of change in relation to teachers were:

- the reform movement in general;
- the principal and school community;
- internal support personnel;
- the spirit of collegiality, collaboration and experimentation;
- the grade level team of teachers;
- innovative curriculum materials;
- the inservice program;
- external support personnel;
- the researcher as audience and critical friend;
- outcomes valued by the teacher;
- day to day conditions under which teachers work;
- teacher knowledge. (p. 186)

The conditions in which change occurs and the level at which it originates generally determine the strategies employed. As defined by McNeil (1985) top-down strategies are often large in scale and include training teachers in new techniques and holding them accountable for following these

techniques. Bottom-up strategies of change start locally and include the teacher as an agent of change. A more political view of change was elaborated by Print (1987) who identified rational-empirical strategies, normative re-educative strategies, and power-coercive strategies. As described by Print, the basic premise of rational-empirical strategies is that people are reasonable and will act in a reasonable manner; normative-re-educative strategies are concerned with changing people, particularly their perceptions and attitudes; and power-coercive strategies are based on the control of rewards and punishment. Reference to an earlier analogy related to change in the car industry and in the medical profession provides examples of the application of the various strategies.

**Teacher Professional Development History**

An examination of the history of teacher professional development might provide further illustrations of the employment of a wide range of change strategies. What can be learnt from any such glimpse into the past is the degree to which each of the strategies has been successful, or unsuccessful, and in what circumstances. Clarke, Carlin and Peter (1992) concluded that previous models of teacher change have given inadequate recognition to the complexities of professional growth, resulting in simplistic descriptions of the relationship between action and reflection. They claimed that inservice programs can stimulate experimentation which can lead to reflection as the mediating process by which a teacher's experience changes that teacher's knowledge and beliefs. Hatfield and Price (1992) and Sharpe et al. (1997) agreed that recent views of change place more emphasis on models such as teacher-mentor, "grass roots" group approaches, key group approaches, collaboration with tertiary institution staff and personal self-development.

*Professional Life Cycles*

The preceding discussion concerning education change contained references to the importance of acknowledging the characteristics of individual teachers participating in any change process. The process of learning to teach has been viewed by many writers in terms of phases of teacher development. According to Wadlington (1995) the developmental phases of teachers are based on the evolution of social roles rather than on mental and physical maturation. Teachers have their own patterns of development as they learn to teach but common stages or phases within professional life cycles have been identified by several writers (Huberman, 1988; Katz, 1977; Maling, 1984; Pederson, 1991; Pinner & Shuard, 1985; Reynolds & Clark, 1984; Scott, 1987, Schools Council, 1990; Sikes, Measor & Woods, 1985).

Figure 2 summarises a sample of life cycles as presented by several of the writers referred to above. Butt et al. (1992), for example, stated that evidence from studies of teachers' professional life cycles illustrates important changes in teachers' concerns, relationships with pupils, and relationships with colleagues, that suggest differentiated learning interests and processes throughout their careers. The research of Kelchtermans and Vandenberghe (1994) demonstrated that the study of teachers' life cycles can provide some insight into the factors and mechanisms that determine qualitative changes in teachers' professional behaviour.

Most writers have identified a similar initial professional phase when the neophyte teacher is grappling with the basics of management, organisation, and control. As the teacher matures professionally it appears that the developmental phases are not as easily identifiable. Perceptions of when teachers experience professional renewal, for example, vary. This highlights the fact that professional life cycles are extremely individual and are influenced by a range of factors including gender, domestic

| Authors | Phases in professional life cycle | | | | |
|---|---|---|---|---|---|
| Katz (1977) | *Survival* Learning to cope | *Consolidation* Gaining skill and confidence | *Renewal* Gaining new skills and enthusiasm | *Maturity* Acquiring confidence and security | |
| Power (1983) | *Induction needs* The period of adjustment after appointment | *Extension needs* Gaining skills in various teaching roles | *Refreshment needs* Renewal after periods of repetitious experience | *Conversion needs* Acquiring skills for a career change | |
| Maling (1984) | *Preservice* Formal teacher education prior to appointment | *Induction* Learning teaching skills | *Inservice* Upgrading professional skills | | |
| Reynolds & Clark (1984) | Survival. Coping with teaching demands | Establishment of control | Development of security and danger of complacency | Critical awareness and activity | |
| Pinner & Shuard (1985) | *Initiation* Seeking and clarifying information | *Consolidation* Developing skills and a teaching style | *Integration* Developing confidence and security | *Reflection* Full awareness and development | |
| Sikes, Measor & Woods (1985) | *Phase 1* *Age 21-28* Coping, learning to survive | *Phase 2* *Age 28-33* Increase in commitments and responsibilities | *Phase 3* *Age 30-40* Conjunction of experience. High level of intellectual ability | *Phase 4* *Age 40-50/55* Plateau in career. Self appraisal. High morale. | *Phase 5* *Age 50-55 on* Freeing up of attitude. |
| Scott (1987) | *Survival* Learning the system | *Consolidation* Developing confidence | *Extension* Extending professional expertise | *Refreshment* Recharging the batteries | |

*Figure 3.* Samples of teacher life cycles.

circumstances, education contexts and larger political, social and economic factors (Huberman, 1993b; Schools Council, 1990).

Inherent in the life cycle research are questions related to the manner in which teachers construe their activity at different periods in their careers, perceptions of the "best years" for teaching, the times when core features of teaching are mastered, and what, if anything, is done about the non-mastered features. Sikes et al. (1985) claimed that career cycles have changed and that there is a search for new career maps and timetables. They went on to say that traditional teaching has been a kind of profit and loss engagement where the difficulties have been balanced out by the advantages, but that in the current circumstances, there is little to balance out the losses. Katz (1995) in a research study which attempted to validate her 1977 work found that there was some support for the "survival stage" but that the data indicated that teachers who were likely to have reached the hypothetical "mature" stage seemed to move out of the classroom to non-classroom roles such as curriculum specialists or administrators. Katz's research also suggested that many veteran teachers had experiences which caused them to revert to the concerns characteristic of the survival stage when their contexts changed. Examples of changes which were reported were the introduction of new curriculum documents and exposure to groups of children different to those which the teacher may have become accustomed.

The professional life cycle literature appears to present a linear view of professional growth. Reference to literature on child development provides reminders that in observing children's development, spurts and regression are to be expected as well as varying rates of progress in different areas of development. Huberman (1993b) considered that evoking a "developmental sequence" in the teaching career is both appealing and problematic. He warned, however, that career sequences may be artifacts

assigned to a succession of events to give meaning to them. Huberman's redefinition of career sequencing in teaching included abandonment of the idea of "stages" in favour of "modal sequences." The modal sequence of significance in relation to this study is that of diversification and change. Huberman claimed that a commonly identified phase in teachers' career cycles was one characterised by experimentation, diversification and a fear of stagnation. Could this be utilised in professional development planning? How could this phase be extended so that fewer teachers move into the phases of conservatism or disengagement described by Huberman? Professional development planners and providers could perhaps speculate on whether similar growth patterns are evident in the professional development of teachers and whether there are significant variations in the development of teachers across a range of curriculum areas.

Pederson's (1991) summary of the report of the English Inservice Education and Training (INSET) program suggested that there are six key stages in developing a career profile and that there are specific professional development needs at each stage. These are:

- induction years;
- consolidation period of 4-6 years during which teachers could attend short specific courses;
- a reorientation period after 6-8 years experience, which could involve secondment for a one term course and a change in career development;
- a period of further studies in advanced seminars, to develop specialist expertise;
- at about mid career after 12-15 years, some teachers could benefit from advanced study programs a year or more long, possibly to equip them for leadership roles;
- after mid career, a minority would need regular opportunities for refreshment. (p. 278)

Pederson's model, like many earlier models, assumes a development in expertise within, and across teaching areas. In Australia there has been a strong commitment by early childhood teachers to the *Early Literacy*

*Inservice Course (ELIC)* and to language-related professional associations (Reeves, 1987). There has also been extensive participation by early childhood teachers in mathematics education professional development programs such as the *Early Mathematics Inservice Course (EMIC)* but not to mathematics education professional associations. The differences in participation in non-compulsory professional development activities provides support for the notion that professional growth across curriculum areas is not uniform. Later discussion will focus on professional development in mathematics education, and survey work undertaken as part of this research will highlight data which showed that there are significant variations in professional development in various curriculum areas. One implication of this differential commitment is that professional development activities need to reflect the individual professional growth patterns of the participating teachers. The key to establishing a career ladder, claimed French (1997), is professional development which should not only enable teachers to leave the classroom for administrative responsibilities but also ensure that some of the best teachers stay in the classroom.

**Effecting Successful Professional Development**

The success of future professional development programs is dependent upon the capacity of planners and organisers to make informed and appropriate decisions based on an understanding of the weaknesses of past practice, consideration of emerging trends in education generally, and professional development specifically, and acknowledgement of the nature of change in education. Ingvarson (1987) reported that educators already have clear ideas concerning the conduct of effective inservice programs. He felt, however, that it is difficult to put this knowledge into practice because

there is a lack of "fit," that is to say, a lack of integration, between inservice education and planning for change. He further claimed that the three major factors contributing to this lack of fit are (a) the diffusion of responsibility for inservice and its isolation from major policy initiatives in areas such as curriculum; (b) a profound lack of understanding of the complex and long-term nature of educational change which is reflected in minimal allocation of resources to professional development; and (c) inadequate support for the development of conditions within schools which provide the leadership, collegiality, time, and organisation required for professional development to become a routine part of schools' day-to-day operations. These factors have been mentioned by other writers (see, for example, DEET, 1988; Lovitt, Stephens, Clarke, & Romberg, 1990; Pinner & Shuard, 1985; Rawlinson & Guild-Wilson, 1987; Robinson & Alexopoulos, 1987; Vartuli & Fife, 1993) and warrant further discussion in the following deliberation on the implementation of successful professional development.

Major factors which influence the success of teacher professional development, as outlined in relevant literature, relate to planning and organisation, the implementation process, the content of programs and activities, teachers themselves, and support mechanisms.

*Planning and Organisation*

The preliminary components of the professional development process, including planning and organisation, are deemed to have considerable impact on the potential for success of professional enhancement programs (DEET, 1988; Docker, 1987). According to Rawlinson and Guild-Wilson (1987) it is a responsibility of education systems to plan and allocate professional experience programs, to coordinate activities, to compile a budget, to set up an information base, and to involve a range of relevant

parties such as tertiary institutions. Andrews (1988) agreed that a systematic approach to inservice education is desirable as is a marriage of school and system priorities. Lovitt et al. (1990) concluded that such a marriage could occur if the support of both teachers and the school administration is secured. Pinner and Shuard (1985), in a study of inservice provision in the United Kingdom, reported that among the important ingredients of planning are the identification of needs and the encouragement of participation through adequate funding and release time. The capacity of the education system to meet its commitments in relation to planning and organisation has a direct relationship to the quality of service delivery.

Inherent in professional development organisation and planning, according to Docker (1987), Pinner and Shuard (1985), and Rawlinson and Guild-Wilson (1987), is the need to equip leaders and organisers with skills in areas such as interpersonal processes (facilitating), communication, working with groups (group dynamics), team work, and decision making. The Commonwealth Schools Commission and the Tertiary Education Commission (1986) proposed that the involvement of personnel in leadership roles should be fostered and that classroom teachers should be utilised as part-time tutors. Rawlinson and Guild-Wilson (1987) claimed that the provision of quality leadership was a responsibility of the education systems which initiated major professional development programs.

When planning and designing professional development programs, consultation with participating teachers is necessary (Rawlinson & Guild-Wilson, 1987; Scott, 1987) to maximise ease of teacher access to the knowledge, skills, and insights sought. Access was cited by Boomer (1987) as one factor which may contribute to limiting participation and may be influenced by hidden selectors such as invitation rather than open application, cost, distance, time, and absence of child care. Rawlinson and

Guild-Wilson (1987) also stated that organisers should encourage and facilitate access.

Logan and Dempster (1992) put forward a set of questions for those involved in professional development. These follow.

1. How does the inservice education program contribute to central initiatives and policies?
   How does it contribute to expected policy outcomes?
   How does it promote the controlled and equitable improvement of all schools or sections of schools?
2. How is the inservice experience embedded in the teacher's daily life?
   How do individual and work groups take control and responsibility for the application of professional development?
   How are opportunities arranged for people to explicate and justify their actions in terms of the agreed technical and ethical criteria?
3. How does the inservice experience enhance teachers' capacities to critique schooling with a conscious understanding of their social, cultural, political, historical, ethical and economic beliefs?
   How does the inservice education experience enable teachers to critique and reconstrue common, valued practices, that is, to question—"the sacred cows of schooling"?
   How does the inservice experience enable teachers to think the improbable and the impossible?
   How does the inservice experience assist teachers to recognise and challenge the implications of their own social histories and personal biographies for their professional practice?
   How does the inservice experience address dominant and orthodox organisational theory.
   How does the inservice experience target the needs of the teachers in order to improve the efficiency and effectiveness of the total system?
   How does the inservice experience build loyalty and conformity to system values and goals in periods of change? (p. 139)

The questions above are complex and the responses demand a high level of commitment to all aspects of the professional development process.

Boomer (1987), in an extensive analysis of aspects of inservice activity that may have a bearing on the eventual outcomes, highlighted the importance of examining the source of initiation. He suggested that the

motives of the initiator in relation to planning may determine the ownership of the activity and the degree of access to it by teachers. Lovitt et al. (1990) reported that enabling participating teachers to feel a substantial degree of ownership in a professional development program contributed to its success. The degree of ownership claimed by individual or collective teachers may be linked to the status of a particular activity. Boomer (1987) argued that the value ascribed to the activity, its recognition by teachers and school administrators as low or high profile, and the intrinsic and extrinsic rewards received as a result of participation, affect teacher perceptions of ownership.

*The Implementation Process*

The delivery of isolated activities is no longer seen to be appropriate as the cornerstone of professional development programs. Cahill (1985) and DEET (1988) recommended that professional enhancement activities should be developmental, that is, they should be delivered as a series of interrelated, rather than discrete, events. A sandwich approach to delivery, enabling the interspersion of practice in teachers' own classrooms with group sessions, is viewed as an appropriate organisational mode (DEET, 1988). An orientation aimed at enhancing the competence of teachers over a period by giving them time and resources to reflect on their current practices and to refine these practices if desired is also supported by Lovitt et al. (1990), Robinson and Alexopoulos (1987) and Scott (1987). The timing and duration of individual activities, and the period over which they might be spread, warrant particular attention during the planning of professional development programs (Boomer, 1987).

Fullan (1982), Docker (1987), Rawlinson and Guild-Wilson (1987), and Scott (1987) reported that successful professional development encompassed

multiple strategies in the delivery of activities including the coordination of a variety of formal and informal elements such as

- training workshops;
- sharing workshops in which participants exchanged ideas and values;
- teacher-teacher interaction incorporating the use of large and small groups;
- one-to-one assistance;
- time for reflection by individuals and groups;
- meetings;
- the setting of priorities for action;
- arriving at a procedure for developing consensus;
- the use of different time modules (for example, pupil-free days, weekend workshops or seminars); and
- a program of professionally-related reading.

Rawlinson and Guild-Wilson (1987) added that it is crucial that the approaches devised are realistic and that there is a balance in professional development programs. Boomer (1987) maintained that the degree to which programs were planned by organisers or clients, and the extent of pre-programming and negotiation affect the success of activities. Beare and Van Raay (1982) claimed that successful inservice activities are self-initiated and self-designed.

The context and venue of professional development activities, according to Boomer (1987), influence the climate of the activity. Some of the decisions made in relation to this aspect of planning include whether activities occur in situ, in a retreat situation, in work time or in the clients' time. Where possible, inservice activities should be conducted in circumstances as close as possible to the participants' workplace

(Alexopoulos, 1986; Commonwealth Schools Commission and Tertiary Education Commission, 1986; Lovitt et al., 1990).

*Contexts*

When considering ways to match the experiences and workplaces of those who have participated in professional development there are some educational contexts which warrant particular attention. In this study it is pertinent to refer to the teaching and sociopolitical environment of teachers in Aboriginal schools. According to Harris (1991) it is probably true to say that in Aboriginal schools in the Northern Territory the effects of political decisions are a more constantly felt influence than they are in mainstream Australia. This is because every political decision about Aboriginal communities is likely to have an impact on the school and the educational program (Harris, 1991).

All of the Aboriginal students in remote schools in the Northern Territory are familiar with two languages to some extent. The majority of them speak an Australian language as their mother tongue and learn English as a second language at school (Harris, 1991). Many teachers and administrators compare the language needs of Aboriginal students with English as a Second Language (ESL) students but the work most pertinent to Aboriginal classrooms, in the context of this thesis, is that which relates to mathematics education of other indigenous groups in colonial or post-colonial countries outside Australia. Harris (1991) focused on one major point: the enormous linguistic difference between Australian Aboriginal languages and English, which is much greater than that between most migrant languages and English.

In most schools in Aboriginal communities there is a grave mismatch between the language and culture of the pupils and the language and culture of their non-Aboriginal teachers and the curricula and textbooks

they are expected to follow. If schools are set up for the express purpose of transmitting the mathematico-technological culture of the dominant group, and the purpose of mathematics lessons is to share mathematical meanings between teacher and pupils, and yet there is a wide difference between teachers and pupils in their understanding of the nature of reality and the way in which they organise their world to find meaning in it, then the stage is clearly set for conflict and failure (Harris, 1991).

Beers (1993) reported, on the basis of professional development work in North American Indian communities, that partnerships in staff development must be adaptable to the communities they serve. VanderVen (1994) claimed that acting from a single perspective and failing to take context into account are practices followed by many unprepared early childhood personnel. The study of teaching, according to Brown, Stein and Forman (1996), has traditionally been cast within behaviorist and, more lately, cognitive psychological frameworks. These frameworks locate learning within the individual with little or no attention to the social and cultural processes that influence the development of thinking and understanding.

Recent mathematics education research literature (Bishop, 1988; Cobb & Bauersfeld, 1995) has acknowledged the role of social, institutional and cultural factors in the processes of teaching and learning. Jones, Kershaw and Sparrow (1995) summarised past approaches to teaching mathematics to Aboriginal children and asserted that formal schooling in the tradition of a Western mathematical-technological culture has been recognised as inappropriate for Aboriginal students in remote community schools. They applauded the emergence of culturally sensitive curriculum and practices.

*The Professional Development Process*

Several writers (Beare & Van Raay, 1982; Fullan, 1982; Ingvarson, 1987) have cited the work of Joyce and Showers (1980) in describing the process of effective professional development. Joyce and Showers (1980) identified the components of training as

1. Presentation of theory or description of skill or strategy;
2. Modelling or demonstration of skills or models of teaching;
3. Practice in simulated and classroom settings;
4. Structured and open-ended feedback;
5. Coaching for application (hands-on, in-classroom assistance with the transfer of skills and strategies to the classroom.

(p. 380)

Fullan (1982) considered the coaching, or follow-through component, to be crucial. This view was supported by Alexopoulos (1986) who asserted that long-term feedback, combined with coaching, is now regarded as the most important element of professional development programs. Some of the required coaching and assistance, according to Beare and Van Raay (1982), could come from peers. Discussion with peers, according to Cahill (1986), contributes to a greater likelihood of reflection and decision-making. The contribution of peer support and other social dimensions of professional development including leadership, support structures, and a positive work environment are also addressed by DEET (1988) and Price (1997).

VanderVen (1994) identified a number of variables believed to enhance the transfer of knowledge and skills. These are:

- Overall culture of professional development setting supports new learning and application to practice;
- Activities address participant values about learning and various practices;
- Faculty show personal interest in learners as appropriate to situation;
- Appropriate practice is positively demonstrated;
- Practice is supervised by a person in the same field;
- Skills are practised to the point of overtraining;

- Participants are encouraged to consider applications of skills in different contexts and to anticipate both barriers and supports to application;
- Teaching strategies relate to learning preferences and styles;
- Cooperative collaborative and peer teaching methods are included in instructional methods;
- Teaching methods clearly approximate the application into practice and tend to be non-traditional such as
  *guided imagery* allows practitioners to visualise the situation and review options for response;
  *case studies* allow the practitioner to identify with the real life situation;
  *simulation* allows for actual practice in replicated, real situations;
- follow-up and maintenance activities; peer coaching, mentoring, regular feedback, occur over an extended time period. (p. 81)

Jennings and Dunne (1997) also advocated the use of case studies and described how these include a process of critical reflection which allows the teacher to accept or reject a particular teaching method from a knowledge base rather than from dogma or prejudice.

*Selection of Content*

The selection of content for professional development programs is another important factor in determining success or failure. Scott (1987), for example, suggested several principles which, if observed, should enhance the probability of designed teacher support activities achieving their purpose. Such activities should, according to Scott, be preventive rather than remedial, and be needs-focused and designed to meet the anticipated or expressed needs of teachers.

Andrews (1988) reported that successful programs tended to focus on improved teaching and curriculum and encouraged the development of a whole-school approach to reform. The importance of addressing areas of concern identified by the clients themselves in the design of successful professional development programs was recognised by Lovitt et al. (1990).

Planners should also consider, according to Boomer (1987), whether the focus of an activity or program is to be a subject field (for example, mathematics) or an issue (for example, multiculturalism), a teaching method or a teaching tool. A further issue pursued by Boomer (1987) was the necessity to identify goals or outcomes and the advisability of planners being aware of whether their aims are to advance knowledge, change values, or encourage products.

The Commonwealth Schools Commission and the Tertiary Education Commission (1986) in the report *Improving Teacher Education* presented a number of principles believed to be part of all effective inservice programs. Three of the principles are (a) that theory is presented as the underpinning of sound practice; (b) that practice is built upon what teachers are already doing in the classroom; and (c) that knowledge should be shared. Fullan (1982) and DEET (1988) also referred to the need for programs to link theoretical approaches with classroom practice and to emphasise issues and concerns of immediate relevance and interest to teachers. Robinson and Alexopoulos (1987) believed that teachers can be empowered to change if the changes attempted are introduced gradually and incrementally rather than by wholesale restructuring of their current practice. An appropriate balance between content and methods focus in the program was considered essential for success (Pinner & Shuard, 1985). Pinner and Shuard also maintained that successful programs enable teachers to take from inservice activities instructional materials that they can use in classrooms.

*Teachers as Learners*

Scott (1987) suggested that professional development planners need to take cognisance of how teachers (as adults) learn, and be oriented accordingly. Jalongo (1991) claimed that research evidence showed that

1. The best teachers are active learners.

2. Teaching knowledge must be constructed.
3. Teachers' learning experiences need to meet their individual needs.
4. Teachers' learning is not restricted to formal classroom experiences.
5. Teachers who are enthusiastic learners have greater insight into children's learning.
6. Teachers who are active learners become researchers into their own practice.
7. Teachers who are avid learners themselves have high expectations for students. (p. 7)

The establishment and maintenance of a supportive climate which engenders a spirit of ownership, fosters self-worth and confidence, and ensures commitment are considered prerequisites for any professional development program (DEET, 1988; Lovitt et al., 1990). It was also important that activities are designed to be non-threatening to those for whom the support is intended according to Scott (1987).

Teachers are more likely to attempt new strategies, according to Robinson and Alexopoulos (1987), if they can try these out for themselves in non-threatening situations where occasional failure is tolerated and where constant feedback on the positive outcomes of the changes they are exploring, in terms of children's learning, is provided. The importance of climate has also been referred to by Boomer (1987) who cited formal, informal, remedial, celebratory, activist, and academic as examples of climates which can be created and which influence the outcomes of programs. Acquarelli and Mumme (1996) claimed that it is crucial that the pedagogy of professional development be congruent with the pedagogy desired in classrooms. As learners, teachers need to experience firsthand the benefits of interaction with others during learning opportunities.

Fullan (1982) stated that, in planning professional development activities, the question of what teachers want should be paramount in the minds of organisers and consideration should be given to the varying responses to offers of support. Fullan (1982) suggested that, in relation to the

implementation of change, there are four major categories of teachers, these being

1. The autonomous teacher who wishes to be left alone to make individual choices.
2. The developer/participator who wants to participate in decisions and development of new materials.
3. The receiver who does not have time for, or interest in, curriculum development but is willing, in fact wants, to have good external materials developed and presented.
4. The interactor who has the desire for more opportunities to interact, share, and discuss with fellow teachers what is being done in relation to a particular new curriculum. (p. 127)

The challenge for planners and organisers is to decide to what extent the needs of each of these groups of teachers are accommodated.

The composition of the client group can influence the outcomes of activities (Boomer, 1987). Aspects of the client group which could be crucial to success include whether individuals or groups are the focus of activities; whether parents and students are clients; whether the male/female ratio among participants; whether clients are beginners or high performers; and whether the target audience is a school, a cluster of schools, a region, an education system, or a national or international network.

The personal aspects of professional development have been discussed by a number of authors (Arends et al., 1978; Beare & Van Raay, 1982; Cahill, 1986; DEET, 1988; Docker, 1987; Fullan, 1982) who have claimed that attention to the characteristics of mature professionals, and the human interaction between helpers and clients, were important factors in successful professional development. Fullan (1982) stated that teachers need to have one-to-one and group opportunities to receive and to give help, and more simply to enter into dialogue about the meaning of change. Support for the promotion of teachers as active, self-motivated and independent learners is crucial if professional development participants are to grow with the program so that the outcomes progressively influence classroom practice.

*Support*

According to Coulter and Ingvarson (1985) professional development should be closely related to the development, implementation, and evaluation of the school curriculum. Consequently an essential step towards effective inservice education is the formulation of a school staff development policy. The provision of active external support to enable schools and individuals to implement their plans is crucial (DEET, 1988). Teachers are aware, claimed Irwin (1994), of a range of sources of support for their professional development. Informal support from colleagues in the workplace is, according to Irwin, a frequently cited source of support. Acquarelli and Mumme (1996) agreed that change requires teachers to become part of a professional learning community. According to Sharpe et al. (1997) many challenges remain in relation to achieving success in collaborative enterprises. These authors considered that specific challenges included initiating communal relationships among participants and overcoming the negative characterisations of professional roles and abilities of significant others within the collaborative relationship. They added that it was also necessary to change the naturally isolating environments from which all collaborators come. Help from outside the school from relevant advisers, professional associations and inservice providers is another common way of gaining access to professional resources. A further option for teachers wishing to improve their practice is to conduct research in their own classrooms.

Docker (1987) considered that schools have a major role in supporting professional development and should develop a school policy and plan based on the needs of teachers. Schools should also be involved in setting the priorities of the state education department and the school, the selection of leaders by expertise rather than seniority; the provision of time for staff to be involved in professional development activities; and the allocation of

resources to allow the activity to be implemented. In its major report, *Teachers Learning*, DEET (1988) stressed the importance of support for professional development via such avenues as effective leadership; external support in the form of consultants, advisers and resource centres; parental support; and collegiate support. Scott (1987) supported this view and added that provision for the maintenance and evaluation of the support were crucial.

Support for professional development includes the provision and maintenance of resources which may include preliminary reading, texts, visits, and demonstrations (Boomer, 1987; Katz, 1977). It also means making available long-term, ongoing support and encouragement while teachers are exploring the possibilities of new strategies in their own classrooms. Regular and appropriate follow-up in the classroom and in subsequent progress review sessions was regarded by Pinner and Shuard (1985) and Robinson and Alexopoulos (1987) to be an indispensable aspect of the professional development process.

Robinson and Alexopoulos (1987) also claimed that support for individual teachers engaged in attempting to improve their professional practice could come from peers if two or three teachers from one school could be involved in the change process at the same time, from other practitioners if teachers are given regular opportunities to meet and share their experiences, from effective leadership, and from an organisational climate which encourages commitment. Several writers (Craft, 1996; Lovitt et al., 1990; Pinner & Shuard, 1985) argued that the involvement of groups of teachers rather than individuals is a characteristic of successful professional development programs as is using the services of a consultant or critical friend.

Several writers (for example, Collinson, 1996; Craft, 1996; Dean, 1991, Johnson, 1990; Jones, 1993) have suggested that teachers may be more

motivated to participate in professional development activities if there is a choice of forms of professional development. They suggested the following range of possible experiences:

- coaching;
- experimental work with children;
- giving a talk to a group;
- job enrichment;
- job exchange;
- job rotation;
- keeping a diary;
- observation and discussion with other teachers;
- personal reading and study;
- preparing a report;
- reflecting on one's own performance;
- shadowing a pupil or being a pupil for one day;
- shadowing a senior colleague;
- taking on responsibility and involvement in decision-making;
- taking part in a group problem-solving activity;
- teaching a variety of groups;
- visiting other schools;
- working with other teachers;
- action research.

Activities identified include action research where the teacher aims to identify an aspect of practice to investigate in order to develop, implement and evaluate a new approach. Action research has tended to focus on the concerns and interests of individual teachers, but the possibilities for peer support and collaborative learning are strong (Craft, 1996).

*Obstacles to Participation*

McNeil (1985) concluded that there are a number of constraints which restrict the participation of teachers in professional development activities. These included lack of time, heavy teaching loads, and perceptions of resistance from parents, peers, and the school. Beeson (1987) added that further constraints included limitations on available resources, difficulties in realising a satisfactory level of coordination between all involved in professional development, and difficulties inherent in some of the desirable approaches to teacher development and collaboration. An analysis by Davis (1987) of powerfulness as a precursor to social action included references to participatory barriers such as intrusive styles of supervision, inadequate resources, insincere or non-existent participatory decision-making, excessive workloads, and structural and organisational actions which dehumanise.

Fullan (1982) emphasised that it is essential to recognise the relationship between professional development and the implementation of change. He perceived that the future of educational change was based on confronting dilemmas such as attaining a balance between cognitive and social goals, and maintaining the spirit of an innovation while encouraging individual adaptation in implementation. Ensuring that individuals derive meaning from the change process is a major goal for the planners and organisers of professional development activities.

# CHAPTER 3

# LITERATURE REVIEW: PART 2

## Professional Development in Mathematics Education

*Context*

The process of change in education is complex. As the discussion in the previous section illustrates, ensuring that innovations are faithfully translated into classroom practice requires understanding of the educational change process in general, and of professional development in particular. Given such understanding it should be possible to effect change in particular curriculum areas. This premise is at the heart of this dissertation which has as its focus early childhood mathematics education. Reflection upon the discourse of contemporary mathematics education has informed the design of data collection instruments which assisted in the documentation of the professional development experiences of a sample of early childhood classroom teachers.

In this section of the literature review the discussion moves from the general to the specific as professional development in a particular curriculum area and a particular sector of the school program are considered. Before examining suggestions for courses of action which may contribute to an improvement in the planning and teaching of early childhood mathematics it is appropriate to consider the context in which change may occur.

Support for change in mathematics education has its genesis in literature and public opinion which state that there is a crisis in which "mathematics and science gaps" are seen as a threat to nations' economic viability in a technologically competitive world (Clarke, 1997; Price, 1988; Putnam, Lampert, & Peterson, 1990; Willis, 1990). Alleviating these "gaps"

is seen as a responsibility of the mathematics education community which has attempted, over the past three decades, to counter criticisms of the quality of mathematics teaching in schools. Significant curriculum reform initiatives were seen in the 1980s in the form of major reports containing recommendations and suggestions for change. Among these were the National Council of Teachers of Mathematics' (1980)*An Agenda for Action* in the United States of America, the Cockcroft Report (1982) in Britain and the NCTM's (1989) *Curriculum and Evaluation Standards for School Mathematics.* Despite the almost universal acceptance and support for the recommendations made in these, and other, reports, change has been slow and variable. In Australia similar change initiatives were evident in the form of the *Australian Mathematics Education Program (AMEP)* (1982), the *Mathematics Curriculum and Teaching Program (MCTP)* (1988) and the Australian Education Council's (1991a) *A National Statement on Mathematics for Australian Schools.* These major national curriculum initiatives and reports influenced the development of other projects within individual Australian states.

Steffe and Weigel (1992) claimed that the demands to improve practice in mathematics education cannot easily be satisfied as there is a backlash against modern mathematics because of its perceived failure to change teaching methods and to acknowledge the results of recent research in mathematics education. They added that the use of constructivism as a philosophical basis for mathematics education could dramatically transform current practice in mathematics education. Zevenbergen (1996), however, argued that acceptance of constructivism as a dominant paradigm is to deny the wider social implications that the learning of mathematics has on those students exposed to institutionalised mathematics.

A number of writers (for example, Cooney, Goffrey & Southwell 1984; Desforges & Cockburn, 1987; Eisenhart, Borko, Underhill, Brown, Jones, &

Agard, 1993) have claimed that one of the problems in mathematics education is ensuring that work done on understanding children's mathematical thinking, on identifying and sequencing educational objectives, and on designing attractive teaching materials, is reflected by change in schools. Eisenhart et al. (1993) concluded that, despite numerous commissions and professional organisations calling for teachers to devote more time and attention to developing students' understandings of mathematics, little acknowledgement has been given to the extensive mathematical and pedagogical skills and knowledge needed to achieve this. Pateman (1989) stated that it is difficult to explain the lack of acceptance of new ideas by teachers when the research community feels that there is a clear body of theory, reasonably well substantiated, which has "obvious implications" for classroom practice. Desforges and Cockburn (1987) claimed that blaming teachers is inappropriate, and that the problem lies in the failure of the mathematics establishment to take seriously the complexities of the teacher's job. Creating a nexus between the expectations of researchers and classroom teachers should, therefore, be a priority for educators committed to change in mathematics education. Lovitt (1993) asserted that this means recognising and treating practitioners as full professional partners in a joint productive enterprise, the enterprise being that classroom learning will be enhanced. The extent to which this is possible is discussed later when reference is made to professional development in mathematics education.

Once the premise that change is a necessary element of education is accepted, important questions spring to mind. These questions include the following which were originally posed by Pateman (1989).

> Why is there so much criticism of the way mathematics is taught? Who are the critics? Who is at fault if the criticism is justified? Is there a remedy? Why should mathematics be taught at all? What mathematics should be taught? How should it be taught? What should influence methodological choices? (p. 2)

Responses to Pateman's questions form part of the ensuing discussion and will be informed by the findings of research from the past decade in relation to the value of mathematics education, change in mathematics education, and successful mathematics teaching. The significance of these issues to the early years of formal schooling are particularly relevant to this study.

## The Rhetoric of Early Childhood Practice

Early childhood educators assert that there are characteristics of early childhood education which distinguish it from other sectors of education. Many writers (see, for example, Gifford, 1993; Hutchison, 1994; NAEYC, 1991; Seefeldt & Barbour, 1990; Weikart, 1994) have suggested that the predominant contemporary beliefs about early childhood education are that it is based in child development, it is about adults and children taking the initiative for learning, it is an integrated approach and that play is the integrator of the curriculum. Edwards and Knight (1994) identified four key concepts in early years practice. These were

- Education should be enjoyable;
- Children construct their own understandings of what they experience;
- Learning is a personal experience that usually occurs in a social context;
- The learning environment is important. (p. 3)

The features identified by Edwards and Knight suggest a view of early childhood classrooms as active, child-centred environments in which there is an emphasis on child-initiated exploration with concrete materials. Later in this thesis the extent to which reality imitates rhetoric will be discussed.

Gifford (1993) claimed that, although there has been a tradition in this century of specialist teaching of children under eight, in Australia the concept of early childhood as a field is relatively new. There is, however, widespread agreement about what constitutes the knowledge base of early

childhood. Ebbeck, Clyde, Veale and Haseloff (1991) claimed that this knowledge base is a rigorous and informed study of human development and curriculum theory. It is also, these authors argued, the development and evaluation of a code of ethics for early childhood teaching, research in early childhood education and teaching methodologies for young children. The major early childhood professional group in the United States of America, the National Association for the Education of Young Children (NAEYC), has defined what early childhood professionals must know and be able to do. The NAEYC's (1991) guidelines state that early childhood professionals should:

- demonstrate an understanding of child development and apply this knowledge in practice;
- observe and assess children's behaviour in planning and individualising teaching practices and curriculum;
- establish and maintain a safe and healthy environment for children;
- plan and implement developmentally appropriate curriculum that advances all areas of children's learning and development, including social, emotional, intellectual and physical competence;
- establish supportive relationships with children and implement developmentally appropriate techniques of guidance and group management establish and maintain positive and productive relationships with families;
- support the development and learning of individual children, recognising that children are best understood in the context of family, culture and society; and
- demonstrate an understanding of the early childhood profession and make a commitment to professionalism. (p. 20)

Weikart (1994) and Glascott (1994) claimed that the discourse of developmentally appropriate practice is predominant in contemporary early childhood education. Teaching which supports developmentally appropriate practice, according to Hohmann and Weikart (1995), is based on a number of assumptions related to development. One of these assumptions is that there are particular times during the life cycle when certain kinds of things are learned best or more efficiently, and there are

teaching methods which are more appropriate at certain times in the developmental cycle than at others.

The major tenets of a developmental approach are regard for each child as unique and the importance of providing children with opportunities to interact, understand and cooperate in groups (Bredekamp & Rosegrant, 1995; Glascott, 1994). According to Weikart (1994) many early childhood educators voice a commitment to the principles of developmentally appropriate practice, such as child choice and independent decision making, yet many programs are characterised by teacher-led subject units, commercial games, or a strong emphasis on inappropriate age-related skill expectations. Wien (1996) contrasted developmentally appropriate practice with what she termed teacher dominion and identified characteristics of each approach (see Table 2). Wien cautioned, however, against situating a particular teacher's practice at either pole of a continuum based on the degree of teacher power evident in their approach. In reality, Wien explained, practice is dynamic, conflicted and complex, and there are many fields of tension intersecting around a teacher.

Gammage (1995) suggested that high quality education for young children may well be the result of them being placed alongside adults who provide organisations which encourage key dispositions rather than simply address basic subjects. Fleer (1995) also argued that early childhood educators need to articulate a new paradigm which focuses on approaches to cognition other than the developmental Piagetian approach which has dominated the field for some time.

Savage (1993) surmised that change in early childhood education is difficult to attain because of the background to the field in Australia. She claimed that the past emphasis on psychological models and theories of learning has not produced reflective or critical teachers. In part this is attributable to work environments which have isolated teachers in

Table 2

*Characteristics of Developmentally Appropriate Practice and Teacher Dominion.*

(from Wien, 1996)

| Developmentally Appropriate Practice | Teacher Dominion |
|---|---|
| 1. The child chooses activity from a broad range of possibilities provided by the teacher, and both teacher and children contribute to the design and the implementation of activities. Power over what to do is shared among children and adults with the adult holding responsibility for the group. | 1. The teacher chooses the activity, its purposes and design, and implements it. Ownership of the activity belongs to the teacher; part of the activity is persuading children to her purposes, motivating them. |
| 2. Children control the agenda for their own activity where they are able to assert it. A broad range of constructive responses is tolerated by teachers. | 2. The teacher controls the agenda for action; that is, there is a prescribed range of possible solutions which the children are permitted. Activity outside the range is corrected. |
| 3. Teachers provide a wide range of activities and materials, among which children may choose and with which they plan and carry out their intentions in many different ways. | 3. The activities are obligatory. Children are to do them in order to learn specific content. |
| 4. Activities are, in general, individual or done in small groups. | 4. The activities are generally conducted in large groups. |
| 5. Different activities occur simultaneously with some children working individually, some with teachers, and a flexible schedule of events. | 5. There is a fixed schedule of timed events with the teacher moving from one activity to the next as she conducts the children through them. |

preschools or infant departments and which have not been conducive to enquiry, reflection, exchange or collaboration. Halliwell (1990) agreed that even experienced early childhood teachers have difficulty articulating their meanings of curriculum when these are not shared by other teachers. She added that, when school systems begin to adopt system-wide procedures for planning, resourcing and assessing curriculum, the subtle differences in perspective with regard to what makes for appropriate curriculum may be lost and there is the potential for the interests of specialist groups to be overlooked. Lack of career structures, lack of incentives for study, poor inservice education and lack of professional organisations have also been cited by Savage (1993) as contributing to a slow rate of change in early childhood education.

Gifford (1993) reported that the drive towards national consistency via initiatives such as the national profiles has placed pressure on early childhood educators to retain the right to teach "the early childhood way." She maintained that many early childhood teachers are currently struggling to teach in developmentally appropriate ways in often unsympathetic school environments and will find difficulty resisting pressures towards narrow uniformity if national and state curriculum initiatives are implemented badly.

The discourse of early childhood education frequently contains an emphasis on the significance of learning processes. The notion of process rather than product being important gives rise to the claim that early childhood educators have no interest in children becoming competent, just in children doing things and enjoying themselves (Halliwell, 1990). One of the myths of early years education, according to Edwards and Knight (1994), that is at last being dispelled is the idea that child-centredness and curriculum-centredness are a simple "either/or." These authors claimed that increasingly early childhood educators are working on ways to establish

and maintain approaches which acknowledge children's interests and development but also ensure integrity of curriculum content. A lack of respect for, and understanding of, the discipline knowledge that forms the basis of particular curriculum areas may contribute to the low status ascribed to mathematics by many early childhood teachers.

## Mathematics Education

It would seem pertinent to question the assumptions upon which claims for elevating the status of mathematics education are made. Why is this component of the curriculum considered important? References to usefulness, contribution to society, potential for contributing to the development of particular skills in students, and recreational or enjoyment benefits are usually embedded in statements justifying the inclusion of mathematics in the school curriculum.

Leder (1989) claimed that the utilitarian value of mathematics is often emphasised. For example, the Australian Education Council (1991a) in its policy document *A National Statement on Mathematics for Australian Schools*, stated that mathematics is useful in everyday life and at work. This notion, however, had already been disputed by Chevallard (1988) who reasoned that all but a few members of society can, and do, live a gentle, contented life without any mathematics whatsoever. Chevallard argued that the explicit uses of mathematics are essential but they are generally concealed from public view and most people, in going about their business, never meet with explicit uses of mathematics except for arithmetic.

Chevallard's view is not shared by Barbeau (1988), Desforges and Cockburn (1987), or Ralston (1988). These researchers submitted that modern citizens need to be confident with mathematical forms of reasoning, skills, and knowledge in order to be able to survive and profit in

their social world and to contribute properly to the development and civilised operation of a technological society. Mathematics underpins most scientific, commercial, industrial, governmental, and technological pursuits, and any society which aspires to be scientifically and technologically modern must be successful in the mathematics education of its children (Australian Education Council, 1991a; Ralston, 1988). Education should equip students to understand their society and culture, according to Barbeau (1988), and exposure to mathematics contributes to such understanding.

The justification for the inclusion of mathematics in the school curriculum can be made in terms of utilitarian, social, economic, and intellectual goals. Teachers' perceptions of the relative importance of these goals can influence the ways in which goals are converted into classroom practice and there may be reluctance on the part of teachers to change their own firmly entrenched priorities. This is particularly relevant in relation to advocacy for approaches to mathematics teaching which reflect an emphasis on broader dispositions, attitudes, and beliefs about the nature of mathematical knowledge and about one's own mathematical thinking.

*Change in Mathematics Education*

School mathematics is changing for a variety of reasons. The mathematical demands of daily life at home and at work are changing and there is a need for people to gain access to, and experience success in, mathematics (Clarke, 1997). In addition, a mathematically educated society is considered to be in the national interest (Australian Education Council, 1991a). In a summary of recent moves to reform mathematics teaching Clarke, Lovitt and Stephens (1990) concluded that calls for reform advocate more than merely changing the content of school mathematics, but emphasise that changes in the teaching of mathematics at all levels are necessary, the critical factor in achieving change being the teacher. Changes

in the content of mathematics are tractable, according to Cooney et al. (1986), but changes in teaching style are far more difficult to achieve, as are changing teachers' perceptions of what it means to learn mathematics.

Since the most significant changes in contemporary mathematics education are in teaching approaches (DEET, 1989), challenges exist for the advocates of reform. Changes in classroom practice will depend on increasing the professional expertise of teachers. How can teachers be encouraged to trial new approaches to teaching mathematics? Which approaches warrant special consideration? A major feature of the evolution of the knowledge of teaching and learning processes as applied to the mathematics classroom, according to Cobb (1987), is the trend towards negotiation of the curriculum with students and a view of teaching as a process in which one attempts to develop shared meanings with students. Implicit in this construal of mathematics teaching is an acknowledgement that mathematics is a living social construct and that the aims of teaching mathematics should include student autonomy and the empowerment of learners to create their own mathematical knowledge (Ernest, 1989b; Kamii, 1985). As a result, mathematics can be reshaped, at least in schools, to give all groups more access to its concepts, wealth and power.

Research in mathematics teaching and learning has a long history of being informed at a theoretical level by insights derived from cognitive psychology (Aubrey, 1994; Bennett, 1989; Taylor, 1996). The adoption of cognitive psychological principles has moved the focus of learning from a behaviourist to a constructivist perspective. Von Glasersfeld (1992) described the two central tenets of radical constructivism as:

1. Knowledge is not passively received either through the senses or by way of communication. Knowledge is actively built up by the cognising subject.
2. a. The function of cognition is adaptive, in the biological sense of the word, tending towards fit or viability.

b. Cognition serves the subject's organisation of the experiential world, not the discovery of an objective ontological reality (p. 23).

The assumptions underpinning this perspective are that it is the tasks on which pupils work which structure the information selected from the environment and determine how it is processed. Steffe and Weigel (1992) argued that establishing school mathematics along constructivist principles characterises the constructivist teacher as a professional teacher with the intellectual autonomy to make decisions concerning mathematics for children, how it should be taught and how it must be learned. They added that teachers must learn about children's mathematical ideas through interactive communication, just as children must interactively build up their mathematical knowledge. Kamii (1996) contended that many educators cannot accept constructivism because associatism and behaviourism seem too valid to reject. She argued that it is not necessary to completely reject older, "wrong" knowledge but to modify it as more adequate theories are constructed.

The need for children to take an active role in their own learning means that classroom teaching practice is characterised by a reduction in adult power, the exchange of points of view with children, encouragement of the exchange and co-ordination of points of view among peers, and encouragement of children to think in their own ways and to engage in activities with intrinsic motivation (Groves & Stacey, 1990; Kamii, 1985; Price, 1988). If a constructivist approach is taken seriously then, according to Mildren (1990), it should be easy to find classrooms where children are engaged in purposeful activity and are constructing mathematical meaning from their interactions with the environment. He went on to say, however, that exemplary classrooms are hard to find.

Groves and Stacey (1990) and Price (1988) have identified other factors which have contributed to change in mathematics education. Among the factors mentioned are recognition of the importance of children's experiences with manipulative materials and how teachers link these to mathematical concepts. The strength of links between various components of teaching is often dependent upon teachers' competence in communication, specifically their choice and use of appropriate language. Ellerton and Clements (1991) claimed that there has been greater acknowledgement of the importance of language factors in mathematics. They contended that any consideration of how language factors impinge on mathematics learning must take account of sociolinguistic considerations. This is particularly relevant when the first language of learners is not English. In relation to this study the work of Harris (1991) supports the notion that Aboriginal children's difficulties with school mathematics may be linked to the characteristics of the language they speak, be this "Aboriginal English" or an Aboriginal language. In her analysis of measurement in Aboriginal communities Harris (1991) argued that there are a number of reasons why programs written in English are likely to be inappropriate and inadequate for vernacular speaking Aboriginal children. Jones, Kershaw and Sparrow (1995), as mentioned earlier, have also stressed the importance of acknowledging sociolinguistic factors in teaching mathematics.

Walkerdine (1988) raised important issues in relation to the language used in mathematical experiences, particularly when experiences were "domesticated," a practice not uncommon in early childhood classes because of a conscious effort by teachers to link home and school experiences. Walkerdine stressed the importance of the teacher's role in scaffolding during the transition from limited contextual understanding to the more abstract conceptualisation necessary for functioning in other situations.

Walkerdine's analysis of child and adult talk provides food for thought in relation to the lack of precision which accompanies what appears to be child-friendly language. When is "natural" language appropriate in order to foster confidence in children and when should the more precise language of mathematics be used?

Other writers (see, for example, Clarke, 1997) asserted that the use of a full range of teaching styles, including the use of co-operative group work to encourage discussion, have contributed to significant change in mathematics teaching and learning. The impact of technology, greater emphasis on investigations and the development of problem-solving skills and strategies, mathematics across the curriculum, mathematics for very low-attaining children, multicultural and gender issues, and the role of parents are other factors which have contributed to change. Willis (1990) claimed that there is a reasonable degree of consensus between Australian state and territory education systems that these are important aspects of mathematics education at the primary school level.

## Early Childhood Mathematics

International studies which have documented concerns about mathematics education generally refer to primary and secondary education and have not included early childhood education (Price, 1989). Little has been written concerning problems in mathematics education as they apply to the early childhood field. Early childhood educators, however, do have some accountability for the problem. Whenever it is claimed that investments in early childhood reduce difficulties in the upper primary and early secondary years, the field is made accountable to some extent for problems which may develop in later years (Price, 1989). A crucial component of the rationale for this research is that early childhood teachers

should be aware of their potential to influence the long-term mathematics learning of the children with whom they interact.

*Influences on the Early Childhood Mathematics Classroom*

Stephens (1990), in a summary of conference participants' perceptions of what influenced early childhood teachers' practice in relation to their mathematics teaching mentioned the historical traditions and constraints surrounding the early childhood phase of schooling and teachers' perceptions of societal and institutional expectations of their role in the classroom. Stephens also reported that the prior experiences of children at home in their learning of mathematics and their access to school and preschool programs were important factors in relation to how and what early childhood teachers might plan.

Teachers need to consider, in their planning, how children see themselves as learners of mathematics and how they learn to identify the substance of school mathematics. Children's views of themselves as mathematics learners would, of course, be affected by their perceived role in relation to the teacher and the perceived traditions of school mathematics. Teachers' involvement in, and attitudes towards, teaching mathematics, according to Stephens, are coloured by their experiences of mathematics in their own schooling and in tertiary education. Teachers' attitudes and involvement are also influenced by their confidence, their openness to children's emergent capacities as creators and shapers of mathematical knowledge and their beliefs about appropriate patterns of work in the teaching and learning of mathematics. Many of the factors outlined by Stephens, such as the importance of recognising children's prior experiences, have also been discussed by other authors as the following discussion illustrates.

*Children's Early Experiences*

There is a growing body of evidence which suggests that, before children come to school, they are inventive mathematical thinkers, albeit with a range of applications necessarily constrained by their limited experience (Aubrey, 1994; Cobb, Yackel & Wood, 1991; DEET, 1989; Desforges & Cockburn, 1987; Owen & Rousham, 1996; Schwartz & Brown, 1995; Shaw & Blake, 1998; Weaver, 1987). In their everyday living children formulate their own problems from the ambiguities of reality, and figure out how to solve these problems in their own ways and in all aspects of their lives (Campbell & Carey, 1992; Clemson & Clemson, 1994; Kamii, 1985; Schwartz & Brown, 1995). Educators need to be aware of children's perceptions about mathematics (through observation and discussion), so that they can build on the children's correct understandings and help them amend their misunderstandings (National Council of Teachers of Mathematics, 1991; Owen & Rousham, 1996). Recognising and building upon children's early mathematical experiences presents educators with some real challenges and the way teachers respond to these challenges has psychological, educational, and sociological implications (Fennell, 1988). Teachers can influence young children's keenness to learn mathematics, according to Clemson and Clemson (1995), by making the tasks they do of interest to them and by showing that mathematics is important and fun and that it is therefore good to be a person who likes mathematics.

Several writers (Aubrey, 1994; Dockett & Perry, 1996; NCTM, 1991; Perry 1989) asserted that all early childhood teachers need to be aware of the informal learning that children will experience and that they need to facilitate the linking of this informal learning with the more formal school-based learning. Some writers, such as Shaw and Blake (1998) and Hohmann and Weikart (1995), have used the term "active learning" and claimed that it

had four critical elements: direct action on objects, reflection on actions, intrinsic motivation, invention and generativity, and problem solving.

*Manipulative Materials*

Booth (1990) maintained that, at the early primary school level, the mathematics taught is essentially empirical, that the focus is on the manipulation of real objects and events and on the solution of particular quantitative and spatial problems. She went on to say that mathematical operations are physical actions on actual sets, and things are proved by empirical demonstration, and disproved in the same way. As a result the child builds up a picture of mathematics as an empirical activity in which you "do" things to discover the mathematical aspects of objects.

There is no question that the presentation of a large section of classroom materials to children to use in making sense of their experiences and refining their mathematical understandings is important (Schwartz & Brown, 1995). In addition, these authors recommend allocation of blocks of time for children to interact with their peers and adults as they use the materials. Providing materials, and time to use them, is only part of facilitating children's mathematics learning. Pengelly (1995) asserted that until recently there was a perception that a "good" mathematics program consisted of an extensive collection of games and activities. She continued by advocating that the emphasis has shifted to a focus on the actual experiences children have and the mathematical thinking which occurs during particular activities. Pengelly (1995) claimed that early childhood teachers have always recognised the importance of experience in learning mathematics but some may have assumed that just by manipulating materials children will learn significant mathematics. Clemson and Clemson (1994) claimed that to be successful in providing children with learning opportunities which will not just get them on to the next phase of

a published scheme, teachers will need to consider ways in which resources can be more extensively and creatively used.

*Play and Mathematics*

As previously mentioned, there is a predominant belief in the value of activity in early childhood classrooms. Teachers in school settings commonly refer to "hands-on" experiences, games or activities to describe experiences which might otherwise be labelled play. Chaillé and Silvern (1996) asserted that active education involves four elements: interest, play, genuine experimentation and cooperation. They contended that interest, experimentation and cooperation are linked within the context of play. Play provides rich contexts for observing children's construction of understanding but teachers need to be able to identify the different types of knowledge being constructed through play. This, perhaps, is one of the challenges for early childhood educators: How is play supported by adults in such a way that learning appropriate mathematical knowledge is an outcome for young children?

*Problems in Early Childhood Mathematics*

Extensive surveys of classroom practice indicate that far from encouraging and developing young children's mathematical inventiveness, the vast majority of school teachers have children playing passive/receptive roles as learners. In this way children are inducted into mathematical routines by, in the main, taking them through a commercial mathematics scheme (Aubrey, 1994; Desforges & Cockburn, 1987). According to Kamii (1985) many opportunities for children to structure and define problems from their own lives are lost when problems are structured via worksheets which encourage obedience, passivity, and the mechanical application of techniques. Bailey (1987) and Aubrey (1994) agreed that there is still too great

an emphasis on pencil-and-paper activities in the teaching of mathematics in junior schools, and concluded that practical activities and the use of apparatus are too frequently scorned in favour of problems which have no relevance to everyday life and are merely computation with words. Often, according to Aubrey (1994), the activities presented are poorly matched to children's existing skills and understandings.

One of the realities of early childhood mathematics education is that certain instructional approaches and curricular topics are given much higher priority than the more appropriate concern for a balanced curriculum and the opportunity for students to develop understanding through use of their own natural approaches to mathematics. In short, far too much emphasis is placed on the addition and subtraction of whole numbers and far too little on spatial experiences, measurement, the development of number sense, understanding the counting process, and problem solving. Campbell and Carey (1992) reported that despite the fact that young children's problem-solving abilities are well documented, the opportunities for problem-solving experiences are limited in many early childhood classrooms. Mathematics educators and researchers argue that current mathematics instruction in elementary and secondary schools focuses too much on efficient computation and not enough on mathematical understanding, problem solving, estimation and reasoning (Cobb et al., 1991; Putnam et al., 1990; Shaw & Blake, 1998).

Wolfinger (1988) reported that, despite knowledge of the way in which young children manipulate and discover their world, there is still an emphasis on standardised curriculum and testing. Discovery through manipulation has been seriously curtailed in many mathematics programs for young children because instruction focuses on correct answers to computational problems. Similarly, it has been documented that textbooks often determine the curriculum in elementary mathematics classrooms and

that many teachers and prospective teachers rely heavily on one or two mathematics textbooks as a main source for planning and teaching mathematics lessons (see, for example, Blane, 1990; Millett, Brown & Askew, 1995). The result is an emphasis on computation and low-level cognitive processes with important aspects such as estimation under-represented. Peterson, Fennema, and Carpenter (1989) concluded that many teachers introduced story problems after children had mastered computational skills, rather than using problem solving as the basis for teaching addition and subtraction.

*Challenges for Teachers*

Carr, Peters and Young-Loveridge (1994) reported that it is often said in early childhood centres that "maths is everywhere" but the range of mathematical experiences planned by teachers was very narrow. Carr et al. (1994) asserted that if early childhood mathematics programs were to be more than identifying and naming shapes and numbers then teachers needed a framework which encourages greater mathematical complexity and interest for children in early childhood. Steffe (1990) suggested that questions of definition should be addressed by teachers prior to action related to teaching mathematics to young children. He asked, for example, what mathematics curriculum might mean, how possible mathematical environments might be established and the nature of curriculum in early childhood teacher education.

*Exemplary Practice*

One of the fundamental principles of teaching early childhood mathematics, according to several researchers (Brown et al., 1996; Campbell & Carey, 1992; Clemson & Clemson, 1995; Cobb et al., 1991; Owen & Rousham, 1996; Schwartz & Brown, 1995; Tirosh, 1990), is the importance of

constructing mathematical environments which allow learners to develop their own mathematical knowledge. This principle is consistent with the rhetoric of developmentally appropriate practice, one of the cornerstones of contemporary early childhood practice. Hohmann and Weikart (1995) identified three criteria which help define developmentally appropriate education. These are that it

- exercises and challenges the learner's capacities as they emerge at a given developmental level;
- encourages and helps the learner to develop a unique pattern of interests, talents and goals; and
- presents learning experiences when learners are best able to master, generalise, and retain what they learn and can relate it to previous experiences and future expectations. (p. 15)

The conclusions from Pinner and Shuard's (1985) research also highlighted the importance of early childhood teachers making maximum use of children's experiences and environment, structuring classrooms to encourage discovery, and using contexts to suggest problems.

The National Council of Teachers of Mathematics (1991), in its position statement on early childhood mathematics education, outlined appropriate curriculum and assessment guidelines which included aims related to children's experiences, the incorporation of active and interactive learning, and language acquisition. The statement also contained references to concept and problem solving orientations, developing children's confidence and ongoing assessment. Further support for practical involvement is found in the work of Seefeldt and Barbour (1990) who considered that the important principles for early childhood mathematics are firsthand experiences, interactions with others, the use of language, and reflection. They claimed that the foundation of mathematical knowledge is centred on the goals and objectives for mathematics learning, and is based on teachers' understanding of how children develop mathematical concepts. It is also,

claimed Seefeldt and Barbour (1990), implemented through sound principles of teaching.

*The teacher's role.* Planning is an important component of teaching in any context and warrants particular attention in mathematics to ensure learning experiences are purposeful. Clemson and Clemson (1995) stated that objectives for learning must be flexible enough to allow the teaching to fit the direction taken by learning, rather than the other way about. Schwartz and Brown (1995) suggested that the essential ingredients for enhancing children's mathematical thinking are providing appropriate materials and the time to use them while providing the type of teacher support that includes effective communication. Effective planning should start where children are (Dockett & Perry, 1996; Schwartz & Brown, 1995). It should also allow a mix of activities which assure children that mathematics is not just "sums" or "schemes" (Schwartz & Brown, 1995). These authors also advocated that teachers should select teaching strategies and group children in ways which support the specific kind of work to be undertaken.

The teaching strategies which can be used to foster appropriate communication, according to Schwartz and Brown (1995) and Smith (1996), are to validate (supporting the child's growing sense of mathematical relationships), to review (strengthening skills and clarifying understandings) and to challenge (extending the child's thinking without additional manipulation of the materials). Owen and Rousham (1996) claimed that educators can provide appropriate experiences (through, for example, play, investigations or practical tasks) and encourage children's thinking through discussion and exposition, but children maintain control over what and how much is learnt. Practical experiences are important but Glascott (1994) has warned that early childhood teachers must understand the theory behind the practice.

Dockett and Perry (1996) claimed that there are a number of implications for children's learning and adult roles in approaches to teaching based on constructivism. Firstly, children's thinking and understanding must be respected within the learning environment. Further, children should be encouraged to collaborate and negotiate meaning. Finally, Dockett and Perry stated, social interaction is a necessary, but not sufficient, condition for learning. Ideally, the identification of these and other factors which are considered to be essential elements in the creation of an exemplary mathematics learning environment should assist teachers who strive to improve their teaching practice.

## Successful Mathematics Teaching

It is apparent from the issues raised in the preceding section that some researchers (for example, Campbell & Carey, 1992; Perry, 1989; Peterson et al., 1989; Wolfinger, 1988) feel that there are weaknesses in the manner in which early childhood mathematics is frequently taught. Why, if there is such compelling evidence to show that some of the features of early childhood mathematics teaching do not enhance student learning, has there been so little change? Perhaps teachers do not have a picture of what an exemplary teachers does. This would appear to be unlikely given that there are many descriptions of successful mathematics teaching. Consideration of these is crucial in relation to planning professional development which introduces or reinforces models of mathematics teaching for contemporary schools.

Acceptance of an approach to mathematics teaching which emphasises student construction of meaning implies acceptance of a reconceptualised vision of the classroom teacher. Brown et al. (1996) and Clarke (1990, 1997) reported that the role of the mathematics teacher is under review. A

conception of the teacher as one who facilitates the sharing of mathematical meaning calls into question the skills once associated with successful teaching and offers an alternative model, the realisation of which promises to challenge, in fundamental ways, the professionalism and self-esteem of teachers of mathematics. Steffe and Weigel (1992) supported this view and added that establishing a constructivist approach to school mathematics characterises the teacher as a professional with the intellectual autonomy to make decisions concerning mathematics for children, how it should be taught and how it should be learned. Prawat (1992), however, asserted that being provided with a new set of theoretical or conceptual "lenses" can be empowering for teachers, but it can also complicate their lives. Teachers who change must work harder, concentrate more, and embrace larger pedagogical responsibilities. The extent to which teachers are able, or wish, to change is one of the issues at the heart of this research. The major research questions focus on the ways in which teachers can expand their professional expertise in the light of current research on mathematics teaching and learning.

Descriptions of successful mathematics teachers abound in recent mathematics education research literature (see, for example, Bromme & Brophy, 1986; Brown et al., 1996; Cooney et al., 1986; Cockcroft, 1982; Hunting, 1989; Steffe & Weigel, 1992). The factor most frequently cited in the analyses of successful mathematics teaching is teacher background and knowledge. Dean (1991) in a broad interpretation of these facets of mathematics teachers' attributes outlined a number of components of teacher background considered to be desirable for teachers. These include:

- knowledge of child development;
- theoretical knowledge of learning;
- pupil motivation;
- content knowledge;

- communication skills;
- ability to observe children and young people;
- skill in recognising the stage the pupil has reached;
- the ability to plan and organise;
- the ability to help pupils to structure their learning;
- the ability to help pupils develop cognitive skills;
- the ability to coach pupils in particular skill areas;
- skill in problem solving;
- skill in controlling children and young people; and
- evaluative skills.

Aspects of classroom management and organisation are also mentioned frequently in discussions of exemplary mathematics teaching. Worthy of speculation is the degree to which these classroom management and organisational factors are important in relation to mathematics education in particular, or to teaching in general. If teachers feel less confident teaching mathematics than other curriculum areas, then teaching mathematics may require different background knowledge, strategies, and organisation.

*Teacher Background*

Fennema and Franke (1992) claimed that no one questions the idea that what a teacher knows is one of the most important influences on what is done in classrooms and ultimately on what students learn. Past experiences, according to Ball (1996), can often act as obstacles to the adoption of new practices. Primary school teachers are often the products of the very system they are trying to reform. Further, an overwhelming proportion of them are women who did not pursue mathematics coursework beyond what was minimally required. Many report feelings of inadequacy and incompetence which influence their interpretation of, and disposition towards, change in mathematics education.

Perceptions of what counts as knowledge have been extensively documented over the past three decades. The ideas of Habermas (1971) has provided a foundation for the work of many other writers (see, for example, Cranton, 1996). Habermas described three types of interests that humans have and claimed that each defines what counts as knowledge in our society. These interests are technical interests and instrumental knowledge, practical interests and practical knowledge, and emancipatory interests and emancipatory knowledge. Habermas claimed that all three forms of knowledge are valid and necessary for human life but he criticised the pervasive application of instrumental knowledge into inappropriate domains. In teaching, according to Habermas, there is important instrumental knowledge which should not be trivialised but there is also critical self-reflection and teacher development which is transformative and emancipatory.

There is, however, no consensus on what critical knowledge *is* necessary to ensure that students learn mathematics. Shulman (1988) identified seven categories of knowledge necessary for teaching. These are content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners, knowledge of educational contexts and knowledge of educational ends, purposes and values. Simon (1994) asserted that, in order for teachers to make shifts towards constructivist classrooms, they must develop knowledge *of* mathematics, knowledge *about* mathematics, useful and personally meaningful theories of mathematics learning, knowledge of students' development of particular mathematical ideas, the ability to plan instruction of this nature; and the ability to interact effectively with students (that is, listening, questioning, monitoring, and facilitating classroom discourse). Several writers (Ball, 1996; Bromme & Brophy, 1986; Darling-Hammond & Hudson, 1990; Fennema & Franke, 1992; Hunting, 1987)

presented a simpler classification and claimed that two basic types of knowledge are perceived to be necessary for effective teaching—knowledge of what to teach (subject) and knowledge of how to teach (methods).

Essential components of subject knowledge are knowledge of the discipline, including the history, philosophy, and didactics of mathematics (Bromme & Brophy, 1986; Cooney et al., 1986; Hunting, 1987), and everyday knowledge (Bromme & Brophy, 1986). Teachers, claimed Acquarelli and Mumme (1996), need to participate in direct mathematical experiences as learners and experience a broader version of mathematics themselves to break free from their traditional views. Schifter (1996) agreed that, through mathematics lessons which challenge teachers at their own levels of competence, teachers can increase their mathematical knowledge. Further, according to Schifter, such activities allow teachers, often for the first time, to encounter mathematics as an activity of construction, exploration and debate, rather than as a finished body of knowledge to be accepted, accumulated and reproduced.

Tobin and Fraser (1989) concluded that, in their study of mathematics teachers, those teachers who were most successful had obvious strengths in their pedagogical content knowledge. Other research evidence also supports this position (see, for example, Brown et al., 1990; Lampert, 1989). Such strengths are evident in the capacity of successful teachers to convey the wholeness of mathematics, rather than presenting it as a disjointed collection of topics (Clarke, 1997). The impact of teachers' knowledge of mathematics, according to Fennema and Franke (1992), is influenced by two constructs: the nature of mathematics itself and teachers' mental organisation of the knowledge they have about mathematics. Schon (1983), however, argued that professional knowledge based exclusively on the traditional disciplines is out of step with the changing situation in a range of

professions, including teaching. He considered that such knowledge was no longer being able to "deliver" solutions to important social issues.

Schon suggested that educators should rethink their views of professional practice and the relationship between theory and practice. The notion of practical and personal knowledge directing teachers' decision making and actions has been explored by other researchers (Elbaz, 1983; Clandinin, 1985; Hyde, 1989; Leinhardt, 1989). Theoretical models which address the links between knowledge of content, decision making, integration and teachers' images of mathematics speak to the complexity of teachers' knowledge (Fennema & Franke, 1992). To accept that practical and personal knowledge is significant is to suggest that the place of discipline knowledge, in conjunction with knowledge of how to teach, needs to be reconceptualised. The latter aspect of knowledge includes understanding the learner, pedagogy and psychology, and curriculum development pertinent to the organisation and evaluation of mathematics experiences for conventional group sizes (Campbell & Carey, 1992; Cooney et al., 1986; Hunting, 1987). Too often, claimed Bromme and Brophy (1988), professional development activities have concentrated on pedagogical content knowledge and the collection of "recipes" for successful practice. Bromme and Brophy argued that this is context-specific, unlike theoretical discipline knowledge, which is more independent of context. Weikart (1994) agreed and stated that what is crucial, in relation to successful mathematics teaching is a balance of discipline knolwedge and pedagogical content knowledge and the integration of these into practice.

Another framework which can be applied to the understanding of teacher knowledge is that of situated knowledge (Fennema & Franke, 1992). The construct of situated knowledge provides insights into the isolation of school-based knowledge and suggests that school knowledge is different from real-world knowledge. This has implications for teacher education.

Fennema and Franke stated that it means that the mathematics that teachers learn must be in a context broader than traditional in-school learning because the situating of teacher knowledge influences the way teachers make instructional decisions about what their students learn.

Corwin (1993) claimed that the goal of encouraging teachers to explore a different, "better" view of mathematics teaching and learning may be difficult to achieve when we consider that many teachers have experienced mathematics as a collection of rules, rituals and routines; an arbitrary, unconnected array of procedures, an authority telling them what to do and how to do it. Mousley, Clements and Ellerton (1992) agreed that although teachers have been encouraged to involve students more actively in the learning process it is not clear precisely what this means for teachers of mathematics wishing to try new approaches. Simon (1994) claimed that a social constructivist view of mathematics provides no model for instruction but does provide a foundation upon which a model can be built. He went on to say that "let students construct the ideas" is overly simplistic and not useful.

Findings from research projects indicate that inservice programs can affect teachers' pedagogical content knowledge and beliefs, and that these changes in knowledge and beliefs are associated with changes in classroom practices and student achievement (Brown & Borko, 1992). The continuing emphasis on pedagogy is important but it cannot be the only component of an inservice program if there is an expectation that teachers spend time on the deeper, broader issues compatible with thinking about change in classroom climate or teaching approach (Corwin, 1993).

*Understanding of Learners*

Successful teachers of mathematics consider individual learners in a range of ways and recognise the special needs of particular pupils. They start

from "where the pupil is at," recognise that pupils learn at different rates and in different ways, allow pupils time to reflect on their own thinking and learning, and respond to the interests, concerns, and personal worlds of the students (Ball, 1996; Campbell & Carey, 1992; Clarke et al., 1990; Del Campo & Clements, 1987). Successful teachers are able to analyse problems with students by drawing on their hypotheses and challenging them to prove them or disprove them (Hunting, 1989; Peterson et al., 1989). They are also able to take advantage of the fact that students are building up their own representations of mathematical ideas, and can provide experiences from which those representations can be formulated. Finally, successful teachers are able to ask appropriate questions which enable them to find out what students' representations are, and to diagnose and challenge faulty or limited representations (Brissendon, 1980; Hunting, 1989). This is achieved by maximising the mathematical work of the pupils and minimising the mathematics done by the teacher.

*Teaching Strategies*

A number of pedagogical principles are now considered to be important in relation to teaching mathematics. Accumulated research on teaching demonstrates that it is a highly complex activity, requiring extensive knowledge and a wide repertoire of skills, flexibility, versatility, and commitment (Darling-Hammond & Hudson, 1990). The selection and utilisation of appropriate teaching and learning strategies are paramount in successful mathematics teaching.

Leinhardt (1989) provided a comprehensive description of the operation of a successful mathematics teacher. She stated:

> The elements needed for constructing expert mathematics lessons are rich agendas, consistent but flexible lesson structures and explanations that meet the goals of clarifying concepts and procedures and having students learn and understand them. Effective lessons in mathematics are not homogenous masses of

> teacher or student activity but move from a teacher-based presentation or explanation of new content toward independent student practice of the material. Expert mathematics teachers weave a series of lessons together to form an instructional topic in ways that consistently build upon and advance material introduced in prior lessons. Experts also construct lessons that display a highly efficient internal structure, one that is characterised by fluid movement from one type of activity to another, by minimal student confusion during instruction, and by a transparent system of goals. These goals are consistently met by the application of cohesive, well rehearsed action systems. In addition, some experts display considerable sophistication in the subject matter presentation segment of their lessons. (p. 73)

Leinhardt's description of expert teaching includes elements such as teacher exposition, mentioned by others (Australian Education Council, 1990; Cockcroft, 1982) as a skill which should be part of a every teacher's repertoire.

Recent research (see, for example, Aubrey, 1994; Del Campo & Clements, 1987; Ellerton & Clements, 1991; Watson, 1989) has recognised the importance of communication and language in mathematics teaching and learning. In the past, non-symmetrical communication has been the norm in mathematics classrooms and teachers often communicated with learners in stereotyped monologic demonstrations (Watson, 1989). In effective contemporary classrooms children are encouraged to share and record their mathematical findings in a range of ways. Successful teachers encourage discussion between teacher and pupils and between pupils themselves (Brown et al., 1996; Cockcroft, 1982; Watson, 1989). The ability to encourage and field questions while knowing enough mathematics to direct inquiry without giving answers to students is also a common characteristic of successful mathematics teachers (Hunting, 1989; Tobin & Fraser, 1989). Teacher questions are used skilfully to focus student engagement and to probe for misunderstandings. When explanations are given, they are clear and appropriate. Campbell and Carey (1992) claimed that, in early childhood classrooms in particular, communication is an important part of effective

teaching as it serves two vital purposes: it fosters children's development of patterns of verbal communication as they talk about mathematics, and it allows teachers to learn about their pupils' thinking. Brown et al. (1996) also stressed the importance of effective communication between teachers and pupils, and between pupils and their peers, as a way to encourage students to assume more responsibility for their own learning and that of their classmates.

Cobb, Boufi, McClain, & Whitenack (1997) extended the discussion of the role of classroom discourse in supporting students' conceptual development by focussing on what they called reflective discourse. These authors claimed that an analysis of reflective discourse clarifies how teachers might proactively support their students' mathematical development in ways compatible with recent reform recommendations. Further, Cobb et al. (1997) argued that reflective discourse is a useful construct in that it suggests possible relationships between classroom discourse and mathematical development.

Activity-based learning by individuals, groups, and whole classes has been suggested as one appropriate mode of organisation for mathematics classrooms (Australian Education Council, 1990; Cockcroft, 1982; Stephens, Lovitt, Clarke & Romberg, 1989). Students should be physically involved in the learning process. In their case studies of Western Australian teachers Tobin and Fraser (1989) found that exemplary teachers used strategies which sustained student engagement, encouraged participation in learning activities, and were designed to increase student understanding of mathematics.

The activities designed by successful teachers provide consolidation and practice of fundamental skills and routines (Australian Education Council, 1990; Cockcroft, 1982), challenge students (Australian Education Council, 1990; Trickett & Sulke, 1988), and encourage students to use a wide

variety of strategies in problem solving and investigation (Australian Education Council, 1990; Clarke et al., 1990; Cockcroft, 1982; Trickett & Sulke, 1988). Rich mathematical activities invite decision-making, speculating, hypothesising, testing, reflecting, and interpreting, and encourage originality, invention, and enjoyment (Trickett & Sulke, 1988).

Appropriate activities contribute to the maintenance of a favourable classroom learning environment (Tobin & Fraser, 1989). The classroom environment created by successful mathematics teachers shows recognition of the importance of risk-taking for effective learning, is non-threatening and encourages the participation of all pupils (Clarke et al., 1990). In an ideal classroom learning environment teachers and pupils engage in a teaching and learning partnership.

## Professional Development in Mathematics Education

*Issues and Constraints*

A challenge for educators committed to effecting change in mathematics education is how to apply the results of current research on the teaching and learning of mathematics to professional development programs so that benefits accrue to students. For this to occur regard should be given to the issues which affect the chances of change occurring in mathematics teaching.

Pateman (1989) speculated on the degree to which problems specific to teaching mathematics can be separated and usefully understood in isolation from the problems of teaching generally. Burkhardt (1988) agreed that there are problems related to implementing change which are not peculiar to mathematics education. In most fields there is generally a slow acceptance of new ideas, and even if innovations are trialled there is a danger that they may be corrupted (that is, the materials may be used in a manner which

conflicts with the author's intentions) or diluted (problems are made easier until the exercises become trivial illustrations of powerful techniques, and in this process the power and generality are neutralised.). The degree of corruption and dilution may be influenced by teacher variables such as background knowledge, style, performance level, adaptability and support (Burkhardt, 1988).

When considering teacher professional development, uniform "professional competence" should not be assumed. Such an assumption, often a feature of craft professions, implies that what one teacher can do, any qualified teacher can do. Burkhardt (1988) questioned the validity of this assumption and stated that in most skilled activities there are ranges of performance. Extending Burkhardt's theory, perhaps individual teachers demonstrate a range of performance across curriculum areas. In the context of this dissertation the interest is in where teachers perceive their mathematics teaching to be in relation to their total range of teaching expertise. Hyde (1989) suggested that the requirement for early childhood and primary teachers to be generalists is an obstacle in relation to encouraging change in a particular curriculum area.

It is vital that teachers recognise the strengths and weaknesses in their various fields of knowledge. Many teachers are attracted to professional development activities which concentrate on practical/professional knowledge characterised by practical ideas for immediate use in the classroom. Bromme and Brophy (1986) argued that there is no justification for the outright rejection, often seen in the literature on pedagogy, of "recipes." They maintained that "recipes" can form useful and valid guidelines for practice within specific contexts. When recipes are collected in a book, however, it is important to examine whether they have been overgeneralised by being presented without mention of contextual factors which may limit or qualify their application. Lovitt (1993) argued that there

is a need to collect a range of classroom images, but that these should be selected for their proven ability to highlight or generate discussion about constructivist principles.

The design and distribution of adequate and appropriate materials is a component of the support required to change mathematics education. Not only are inservice and training necessary, but also strong support at the classroom level through the provision of adequate and appropriate facilities and equipment for teaching, as well as good leadership on the part of subject leaders and administrators (Cooney et al., 1984; Hyde, 1989). Further support, according to Howson (1988), is needed in the form of curricula which encourage weak teachers to become stronger and allow good teachers to demonstrate their talents. Howson claimed that improvements in schools must be "teacher-led" because it is the teacher who must implement any changes and who must demonstrate to other teachers that the innovation proposed is actually workable.

The determination of teacher roles in teaching and learning is a major issue in terms of the professional development of teachers in mathematics education. Ernest (1989a) identified four student learning models; (a) the compliant behaviour and mastery of skills model; (b) the reception of knowledge model; (c) the active construction of understanding model; and (d) the exploration and autonomous pursuit-of-own-interests model. Research suggests that teachers should be favouring the latter two models. This entails overcoming a view of mathematics teaching in which students are seen as "raw material" to be transformed by "skilled technicians" (Romberg & Carpenter, 1986). This does not mean, however, a rejection of common practice but rather a reorientation through the use of teaching techniques which concentrate on real problems. Such problems would be germane to children's interests and would demand the development of

procedures and concepts as well as strategies of enquiry and application (Desforges & Cockburn, 1987; Willis, 1990).

Desforges and Cockburn (1987) claimed that the conservative nature of the teaching community has been criticised most persistently for the general rejection of methods of teaching considered to foster the attainment of higher level learning goals such as learning to learn, problem-solving, and learning strategies. Pateman (1989) asserted that teachers, once they are in the field, resort to using the very methods of teaching that they experienced as learners themselves because they are pressured to conform by other staff members and it is easy to resort to what they feel they know best. Hatfield (1989) agreed that it appears that the most powerful influences on beginning teachers are the perceptions they formed of their own teachers and their own experiences as learners. Burkhardt (1988) claimed that inertia is one of the notable features of education systems and that innovators should keep the question "Why should anyone change?" high on the planning agenda of their work. For example, exposition by the teacher, followed by consolidation and practice, has long been a model for the teaching of mathematics in many schools (Jaworski, 1988). Its perpetuation has a lot to do with its "safety" because it is familiar (many teachers were themselves taught by that model), it is expected (many pupils have been brought up to regard it as the right and proper mode of teaching), one's colleagues use it (safety in numbers), and discipline and control are well defined and relatively easy to achieve. Skemp (1986) considered that there are other reasons for teachers resorting to traditional, known teaching strategies and these include the backwash effect of examinations, overburdened syllabi, assessment difficulties, and the great psychological difficulty for teachers of accommodating (restructuring) their existing schemas.

It is then necessary, according to James and Underhill (1990), for professional development providers to attend to the problems of transition

from transmission to constructivist models of learning. As Clarke et al. (1990) and Zevenbergen (1996) have pointed out, it is not easy for teachers of mathematics to change their teaching methods. Impediments to change are usually deeply embedded in established patterns of classroom behaviour and these reflect deep-seated assumptions about the nature of school mathematics and how it is best taught and learned. For teachers, changing their teaching approach is a difficult and threatening process which cannot be achieved simply by hearing about or reading about new teaching methods (DEET, 1989). Cobb and his colleagues (1987), in a research project aimed at encouraging teaching consistent with a constructivist view of learning, encountered the dilemma of resolving the tension between this position and the need to meet "institutionally-sanctioned goals of instruction," that is, for students to learn particular, accepted mathematics. Blane, Maurer and Stephens (1984) and Hyde (1989) supported a view that the major constraints on teachers are the organisational features of schools which inhibit change and the complex relationships between teachers' actions, knowledge, beliefs and attitudes.

Price (1989) argued that a common human reaction is to devalue the things at which one does not excel and that teachers who feel weak in mathematics sometimes exhibit that reaction by downplaying the importance of mathematics. In so doing they undermine children's motivation to engage in mathematical thinking. Teachers who feel weak in mathematics sometimes mystify mathematics, making it seem hard and impenetrably mysterious. Pateman (1989) purported that there can be little doubt that many teachers, particularly at the primary school level, feel personal discomfort with the level of knowledge of mathematics. Historically, in Australia, the USA, and Great Britain the primary school teacher has seen teaching as a way of aspiring to a profession without being successful at mathematics. Watson and Chick (1993), in their description of

one Australian professional development program, have articulated the need for presenters to provide positive support for participants, particularly those with poor mathematical self-esteem. Hyde (1989) felt that it was crucial to consider teachers' willingness to confront their own knowledge limitations and their own anxieties about mathematics and its teaching. Hyde suggested that this required the creation of structures and processes that foster a desire among teachers to improve their teaching.

Robinson and Alexopoulos (1987) and Sharpe et al. (1997) claimed that teachers have some compelling reasons for staying the way they are. They are isolated in their own classrooms and seldom get the chance for meaningful professional interchange. They are not encouraged to become risk takers, nor given ongoing support during the change process. If, despite all this, they do manage to generate any new educational ideas, they receive scant recognition from the system. Is it surprising, then, that the rate of change is slow?

**Changing Models of Professional Development in Mathematics Education**

Ellerton, Clements and Skehan (1989) argued that almost all attempts to change school mathematics have been based on the centre-to-periphery model of change. In the traditional change cycle described by Ellerton et al., change is initiated by "outsiders" and, for most of the change cycle, control of the change process rests in the hands of persons who are not directly involved in teaching children. When participants in large scale reforms have not felt involved in the planning and implementation of change initiatives, the long-term success of such initiatives has been reduced (Ellerton et al., 1989).

In the 1980s, changes in approach to professional development in mathematics education were evident in Australia. With financial assistance

from the federal government's *Basic Learning in Primary Schools (BLIPS)* program some state governments initiated professional development projects which rejected the prevailing instrumental view of teachers and began to treat them as responsible professionals (Robinson, 1989). Many of the projects which came under the *BLIPS* umbrella were based on an action-research change spiral. The change initiative was informed by a contemporary theoretical perspective and the major change agents were teachers directly involved in classroom teaching (Ellerton, et al., 1989). For example, in Victoria, the Ministry of Education's *Key Group* scheme in numeracy set out to involve participants in their own development. Focus issues for professional development activities were generated by teachers at individual schools. Robinson (1989) described this new perspective on professional development as the "empowerment paradigm."

The *Key Group* scheme involved inviting three early childhood teachers from a school to form a team, providing mutual support for each other. Assigned to each group was a mathematics consultant to provide ongoing support from an outside perspective. The group received financial support and release from classroom duties. It met initially for a three day live-in planning conference and later to reflect upon the implementation of the school-based plan. The success of *Key Group* illustrated the power of empowerment in facilitating meaningful and ongoing change in education. The principles upon which the scheme was based have since been adopted in other professional development programs (for example, *TIME* [*Teachers' Inservice in Mathematics Education*] in New South Wales and *EMIC* [*Early Mathematics Inservice Course*] in Victoria and the Northern Territory). There were, however, modifications to the *Key Group* model because of the need to introduce programs across whole states or territories.

Models such as *Key Group* emphasis pragmatic links between theory, research, and practice in a number of ways (Wolfe, 1994). First, the

curriculum is problem-centred and site-specific. Second, participants are actively involved in applied research. They identify issues relevant to their own needs and design a research study around those issues. In the process, they become consumers of research as they study and apply the work of others. They also become researchers themselves, creating knowledge and learning to think critically about educational ideas and practices (Wolfe, 1994). Such an approach has been adopted in the more recent *Mathematics in Schools* project funded through the *National Professional Development Program.*

*Successful Professional Development*

If greater change in mathematics education is a desired outcome then professional development programs should be tailored to overcome the obstacles to implementing change in the classroom. Professional development activities in mathematics education are important for a number of reasons. First, they provide teachers with the time, means, and support for developing professional competencies (Cooney et al., 1986; Pinner & Shuard, 1985; Hyde, 1989). Second, they increase teachers' knowledge of pedagogical approaches and their perceptions of what constitutes mathematics (Cooney et al., 1986). Professional development experiences also involve teachers in curriculum development including some aspects of quality control regarding curriculum materials development (Cooney et al., 1986) and improve school resource utilisation (Cooney et al., 1986). Finally, they enhance leadership development (Cooney et al., 1986; Pinner & Shuard, 1985). The importance of mathematics studies in professional development has also been stressed by DEET (1989) in its report *Discipline Review of Teacher Education in Mathematics and Science.* The report cites two kinds of essential studies, the renewal of enthusiasm for mathematics through short seminars and

workshops on new topics in mathematics, and the opportunity for teachers to expand their basic knowledge backgrounds.

Any rationale for continued professional development in relation to mathematics education needs to be supported by planning based on sound pedagogical and organisational principles. Willer (1994) extrapolated a number of principles from research on effective professional development; some of these principles have already been discussed in relation to professional development in general, but none have made specific reference to mathematics education.

Willer (1994) reiterated the point that effective professional development opportunities are structures to promote clear linkages between theory and practice. Peterson et al. (1989) concluded from their research with classroom teachers that intervention strategies can be successful in assisting teachers to gain access to the substantial literature regarding the psychology of children's classroom learning of mathematics. Extensive and ongoing inservice education support is essential to give teachers access to this knowledge so they can enhance their understanding of children's classroom learning in mathematics and improve their classroom instruction (Queensland Board of Teacher Education, 1985). Professional development experiences are most effective when grounded in a sound theoretical and philosophical base and structured as a coherent and systematic program (Willer, 1994).

Professional development experiences, according to Willer (1994), are most successful when they respond to individuals' backgrounds, experiences and the current contexts of their roles. New instructional practices should be presented in programs which acknowledge teachers' current practice and should allow the development of skills that emphasise student involvement (Clarke, 1990). In putting forward a reconceptualised model of teaching activity, consideration must be given to the teacher as

learner, and to the process of professional development within mathematics education (Clarke, 1997). Programs which incorporate such principles, according to Clarke et al. (1990) should convey to teachers, in practical terms, a clear image of what change will mean in the classroom.

Teachers are being required to take more responsibility for their own professional growth and for curriculum development. They therefore need to have opportunities to gain experience in the selection of mathematical topics, resources, and teaching approaches (DEET, 1989). Relevant inservice needs in this area include knowledge of national and international curricula, movements and trends in new curricula, teacher resources in mathematics, and experience in curriculum decision-making.

A team approach may be one way of providing programs for teachers who work together. Follow-up and support are facilitated by this approach. A number of authors (see, for example, Ball, 1996; Hyde, 1989; Willer, 1994; Wilson, 1988) considered that professional support, combined with investment of self and continuous nurturing are critical variables in teacher involvement in curricular change.

NBEET (1993) has recommended that schools and education systems should give greater attention to the facilitation of workplace learning as an essential component of the overall professional development of teachers. Clarke (1997) reported that the principal and the school community, as well as internal support personnel, were among twelve major influences on the process of changing teacher roles. Other influences included the spirit of collegiality, collaboration and experimentation to be found within the school and the grade level team of teachers.

Support from the school should also include the provision of space, materials, and equipment. Clarke, Lovitt, and Stephens (1990) and Clarke (1997) recommended that exemplary curriculum materials can assist teachers to think about their current roles and to modify the ways they

teach. Pinner and Shuard (1985) also reported that teachers should take from inservice programs instructional materials which they can use in classrooms.

Cockcroft (1982) and Wilson (1988) identified a range of inservice support which is appropriate in mathematics education. Included are within-the-school activities, meetings with other teachers, visits to other schools, involvement in professional associations, involvement of staff of education departments and tertiary institutions, and inservice courses. The Mathematical Association of Victoria (1989) endorsed the involvement of professional associations and suggested that appropriate activities for such agencies included single-session activities, ongoing programs of from two to four sessions, certificate courses, state conferences, and activities involving students.

Pinner and Shuard (1985) and Wilson (1988) cited the involvement of tertiary education staff in school-based programs as an increasingly popular form of professional development. They reported that tertiary education staff often work with just one or two staff for periods up to a year and so are able to provide the sustained support which may have some permanent influence. This form of professional development is particularly valuable where teachers feel isolated from outside contacts and help in mathematics, and where teachers lack confidence in teaching the subject. Many teachers are insecure and like help within the school. The benefits from a tertiary education/school professional development program accrue to both parties: schools and teachers are helped and tertiary education staff are able to work in schools. A further strength of this model of professional support is that the results of research are communicated directly to teachers.

In relation to mathematics education there are many issues of concern (Jaworski, 1988), the pursuit of which could provide a basis for a range of professional development activities. Major concerns are those relating to

definitions of mathematics, appropriate communication, defining what constitutes a productive mathematical task for pupils in the classroom, and assessment of pupils' mathematical progress, control of curriculum, and relating mathematics to the real world (Greer & Mulhern, 1989; Jaworski, 1988). The challenge for educators involved in mathematics education professional development is how to engage teachers in the exploration of these issues so that the mathematics learning of children is enhanced.

# CHAPTER 4

# METHODOLOGY

## Scope of the Investigation

The study of early childhood teachers' professional development experiences in relation to mathematics education aimed to obtain a rich and detailed description of this aspect of teachers' work. It was, therefore, imperative to use a range of data gathering methods which did not necessarily fit within one methodological framework. The research did not begin with a substantive theory or hypothesis. The intention was that the outcome of the research would lead to a clearer definition of early childhood teachers' professional development in mathematics education.

## Major Research Questions

The literature relating to teacher professional development and mathematics education which has been reviewed in this thesis endorses the initial, tentative hypothesis that, collectively, early childhood teachers, and perhaps also primary teachers, do not have a strong commitment to mathematics education professional development. The aim of this investigation was to support or refute this hypothesis by analysing data pertinent to the professional lives of a sample of teachers through an examination of the influences on their mathematics teaching. Understanding how teachers' thoughts, actions and knowledge have evolved and changed throughout their personal and professional lives helps educators to understand how classrooms have come to be the way they are and how they might become otherwise, according to Butt et al. (1992). The theoretical framework for this investigation was derived from the discourse on change in education and mathematics education. It is

apparent that, despite an increase in the number of research studies related to learning and teaching mathematics, classroom teachers continue to lack knowledge and confidence in both mathematics and mathematics education. Some explanations for the lack of interest and sustained involvement in this component of teachers' professional development are to be found in the research literature. Although these have been considered in the design of the data collection instruments, the employment of open-ended questioning allowed for an alternative range of participant responses.

The choice of a methodology which has at its core the collection of descriptive data is appropriate in an investigation which seeks to chart the territory of teacher professional development. Such mapping is possible through the application of questions which are hierarchically arranged.

The major research questions were:

1. What are the major elements of early childhood teachers' past personal and professional lives which have relevance for their mathematics teaching?
2. How have the professional development experiences of early childhood teachers influenced their knowledge, attitudes and interests in relation to mathematics teaching?

Associated, and more specific, questions to which responses were sought were:

3. What are early childhood teachers' interests in relation to mathematics education?
4. What are the concerns of early childhood teachers in relation to mathematics education?
5. What do early childhood teachers perceive to be their professional development needs in relation to mathematics education?

6. How do early childhood teachers feel their professional development needs and interests can be met?

Responses to these questions came from four sources; a questionnaire administered to a random sample of two hundred early childhood teachers, individual interviews with four early childhood teachers, interviews with key informants, and document collection. Further dimensions of the major and associated questions were explored in a range of ways. An historical perspective to early childhood mathematics education in the Northern Territory was initially explored through interviews with key informants. These key informants were selected because of their present or past formal roles in planning, policy, and publication in mathematics education and early childhood education in the Northern Territory. A review of official documents from the Northern Territory Department of Education, Catholic Education Office, the Mathematics Teachers' Association of the Northern Territory, and individual schools provided further information which assisted in compiling a composite picture of professional development activities in the past ten years.

## Background to the Methodology

### *Qualitative Research Methodology*

Researchers in sociology and anthropology have used approaches now described as qualitative research for a century (Bogdan & Biklen, 1998). Qualitative research flourished through the 1920s and 1930s and the field research of anthropologists such as Malinowski and Mead was an important source for the model of what is known as "Chicago Sociology." The "Chicago School", researchers based in the sociology department of the University of Chicago in the 1920s and 1930s, made a major contribution to the development of the research method referred to as qualitative. The

recognised leaders of case study research, these researchers portrayed their work as being non-quantitative, emphasising the history and context of their cases, avoiding generalisation and inductively attempting to understand social life from the perspective of the actor, rather than from a deductive, theoretical stance (Bogdan & Biklen, 1998; Glesne & Peshkin, 1992; Stoecker, 1991). Qualitative research methodology has operated under various labels: ethnography, participant observation, qualitative observation, case study, or field study (Lubeck, 1985; Merriam, 1998). Terms such as phenomenological, interpretive, ethnomethodological and ecological are also associated with qualitative research (Bogdan & Biklen, 1998). Uses of terms may vary but there are some major features of qualitative research which are consistently identified. According to Bogdan and Biklen (1998) these are that it is naturalistic, it yields descriptive data, it is concerned with process, it is inductive and it is concerned with meaning. In essence, qualitative researchers attempt to capture informants' perspectives and discover how they interpret their experiences.

*Ethnography and Education*

Educational ethnography did not become an acknowledged sub-field of the social science discipline until the 1970s (Lubeck, 1985; Stenhouse, 1982b). Although writers such as Spindler (1982) had done early work in the field, the social upheaval of the 1960s was a major spur to the foundation of an educational anthropology (Bogdan & Biklen, 1998). Numerous researchers have now attempted to outline and define the characteristics of an ethnographic approach to studying education (Bogdan & Biklen, 1998; Erickson, 1979; Glesne & Peshkin, 1992; Lubeck, 1985; Merriam, 1998; Powney & Watts, 1987; Rist, 1978; Spindler, 1982; Stake, 1988; Stenhouse, 1982b; Wilcox, 1982; Wolcott, 1973). Education research has been dominated by quantitative and experimental conceptions of research (Hymes, 1982;

Merriam, 1998; Spindler, 1982). The tried and true methodologies and research designs used most widely in educational research, however, have failed to answer pressing questions. Experimental and correlational approaches isolate variables from context but overlook the critical dimensions of meaning in human behaviour. Ethnography can shed light on old problems and ask new questions which will make some of the old problems obsolete. It cannot do this, however, if it is prematurely killed by the hostility inevitably directed at highly qualitative and descriptive research methods—methods most professional educators and social scientists have been taught to believe are unacceptable (Spindler, 1982).

Ethnographic techniques are part of a research tradition which has been developed by anthropologists and community-study sociologists. These methods have been found useful for describing what people are, how they behave and how they interact with each other. Woods (1986) argued that ethnography is particularly well suited to helping to close the gap between researcher and teacher, educational research and practice, and between theory and practice. The ethnographic tradition is one of interpretivism. Central to interpretivism is the idea that all human activity is fundamentally a social and meaning-making experience which is complex and constantly changing (Bogdan & Biklen, 1998; Glesne & Peshkin, 1992). Interpretivist research goals are to provide information which will enable the investigator to make sense of the world from the perspective of participants, and to be involved in the activity as an insider (Eisenhart, 1988; Wilcox, 1982; Woods, 1986). The resulting description is expected to be deeper and fuller than that of the ordinary outsider, and broader and less culture-bound than that of the ordinary insider (Wilcox, 1982).

It is easy for anthropologists of a variety of persuasions to criticise quantitative methods but often harder for them to state concisely the alternatives. Ethnography cannot be assumed to be something already

complete, ready to be inserted as a packaged unit into the practices and purposes of institutions whose conceptions of knowledge and research have long been different (Hymes, 1982). The fundamental assumptions that underlie ethnographic research, as it derives from anthropology, are not generally applicable to education because of the difficulties inherent in long-term, single-site research and it is important that education researchers clarify the difference between full-scale ethnography and ethnographic studies (Heath, 1982). The term "condensed fieldwork" was coined by Walker (1974) to describe the short-term ethnographic work frequently carried out by education researchers.

Educators are drawn to ethnography because they want to achieve a better understanding of the teaching/learning process, the factors which contribute to the development of children's skills, and the role of schooling in society (Mehan, 1982). The descriptive power of ethnography assists in developing an understanding of the culture of schools. According to Spindler (1982), the real-life purpose of studies of schools, classrooms, administration, and curriculum is to help to make it possible to change things for the better. The monumental resistance to change in education institutions is not simply because educators are conservative or especially incompetent, but because schools are transmitters of culture and exist within a community context. Ethnographers argue that appropriate education research considers the broader context of the classroom and the school, and provides greater understanding of the conditions which facilitate change.

Supporters of action research (for example, Carr & Kemmis, 1986; Nias & Groundwater-Smith, 1988) have argued that, although ethnographic studies may enable description of the context and identification of factors which support or hinder change, it is action research which is able to bring about change. Burns (1990) described action research as both an approach to

problem solving and a problem-solving process. The focus in action research is on a specific problem in a defined context, and not on obtaining generalisable scientific knowledge. In the context of this investigation it was considered that action research would be an appropriate methodology to employ in a later research project after specific problems of practice had been identified.

The potential for rich description, accurate explanation, and analysis of causation are strengths of ethnographic research which has enjoyed an upsurge of popularity in the past decade (Stoecker, 1991). Recently, qualitative paradigms have regained respectability in education research but autobiographical research remains controversial since its data are subject to incompleteness, personal bias, and selective recall in the process by which the narrative is reconstructed (Butt et al., 1992). Greater rigour to increase internal validity is now possible through triangulation and continual, rather than sporadic, data collection.

One strength of ethnographic research is its capacity to take a holistic view of the situation by concentrating attention on the way particular groups of people confront specific problems. Researchers generally have some expectations and directed vision, but there is a readiness to reconceptualise the problem as the data accumulate, and to take account of the broad slice of social reality (Shaw, 1982). This contrasts fundamentally with research based on a positivistic experimental design.

Woods (1986) outlined a range of educational uses for ethnography and suggested that new research is needed in a range of areas including teacher identities, their interests and biographies; how they adapt to the role, how they achieve their ends; crisis points in teacher careers and what kinds of assistance are of most value to them and at what stages in their careers. Woods continued that many teachers do not "feel right" about their teaching and do not operate effectively. He hypothesised that studies which

reassess teachers' experiences, abilities, interests, aspirations and accomplishments may reveal new lines of career, new possibilities, new sources of satisfaction and new ways of harmonising one's own personal resources within the limitations of individual teachers' professional and personal contexts.

*Mathematics Education Research*

Sowder (1989) stated that mathematics education research, as a separate field of scholarly inquiry, is an essentially twentieth-century phenomenon. Important early studies were conducted by educational psychologists such as Thorndike, Judd and Brownell (Kilpatrick, 1992). The dominant research methodology in mathematics education relied on the statistical model, widely adopted in experimental biology and psychology. The results of the application of this model to mathematics education have disappointed teachers and researchers alike because the studies do not appear to be connected to one another and do not appear to offer cumulative knowledge (Sowder, 1989).

From the 1950s research in mathematics education began to develop more systematically (Kilpatrick, 1992). An international community of researchers exists that holds regular meetings, publishes journals and newsletters and contributes to a research consciousness. Topics on which research has begun to emerge more recently include teachers' beliefs about mathematics and affective issues in the teaching and learning of mathematics. This emphasis on the study of the teaching of mathematics occurred as policy makers began to consider how teaching was proceeding, rather than examine only the curriculum itself (Sowder, 1989).

Mathematics educators have been attracted to more interpretive approaches to research in which researchers enter the classroom and try to capture the participants' understandings of what they are teaching or

learning. Along with this view of research as interpretive understanding has come greater use of qualitative research methodologies borrowed from anthropology and sociology. It is believed that these approaches allow researchers to enter into a dialogue with teachers and students which can begin the process of making their concepts and findings available to practitioners (Sowder, 1989). Over the last decade there has been a move away from the empirical-analytical tradition towards interpretive, and to a lesser extent, critical approaches (Kilpatrick, 1992; Schratz, 1993).

*Qualitative Studies in Mathematics Education*

Recognition of the value of qualitative research in mathematics education is largely attributable to the work of Erlwanger (1975) whose case studies of children's conceptions of mathematics illustrated that the study of one case could influence the way in which the members of the wider mathematics education community perceived the nature of teaching and learning. Ethnographic methodology has recently been utilised to describe inservice education in primary mathematics education (Pinner & Shuard, 1985), to investigate the process of curriculum change and professional development in a school mathematics department (Sigurdson, 1985), to explore the primary-secondary school mathematics transition (Clarke, 1989), and to study the mathematics teaching of neophyte teachers (Sullivan, 1989). Such studies have provided insights into the teaching and learning of mathematics not accessible through the application of other methodologies.

Thompson (1992) claimed that as part of the broader research on teachers' cognitions there has been a reconceptualisation of teaching which has seen a shift in the research agenda towards an understanding of teaching from the teachers' perspectives. With a more informed view of teaching and learning the mathematics education research community now knows that it was naive to measure teachers' knowledge of mathematics in terms

of the number of completed tertiary level mathematics courses and to realise that no description of mathematics teaching and learning is adequate and compete unless it includes consideration of the beliefs and intentions of students and teachers.

Teacher educators should have a commitment to investigating ways of helping teachers reflect on their teaching experiences. According to Thompson (1992), they must find ways of helping teachers become aware of the implied beliefs and rules that operate in their classrooms and help them to examine their consequences. Thompson claimed that it would seem that presentation and discussion of some research could be useful in helping teachers examine their beliefs and practices. Research can provide food for thought; certainly case studies of teachers can be used intentionally to prompt teachers to reflect upon and examine their beliefs and practices. Researchers should be cautiously optimistic, however, about the potential of using research to bring about desirable changes in teachers. Changes in teachers' practices are unlikely to result from presenting, examining, or discussing research studies alone. Whether such efforts have an effect depends on the extent to which teachers are willing to modify their existing conceptions to accommodate the new ideas and how, if at all, those ideas are translated into action. Schon (1987) noted that

> In the terrain of professional practice, applied science and research-based techniques occupy a critically important though limited territory, bounded on several sides by artistry. There [is] an art of problem framing, an art of implementation, and an art of improvisation—all necessary to mediate the use in practice of applied science and technique. (p. 13)

*Data Collection Methods*

In general, the techniques for collecting information for ethnographic research in education have been adopted from the wider tradition of sociological and anthropological fieldwork. Interpretivist methods are

eclectic and include participant and non-participant observation, interviewing, the search for artifacts, researcher introspection, and the negotiation of products (Adelman, Jenkins, & Kemmis, 1982; Eisenhart, 1988). Ethnographers of schooling have employed a wide variety of data gathering techniques. Traditionally, from the ethnographer's point of view, the gathering of many kinds of data has been seen to increase the validity and reliability of the study and to establish the uniqueness of each setting. Each area of study has been thought to require a tailor-made set of methods and techniques (Wilcox, 1982).

*Methodological Problems*

However different the objects of investigation and the goals of inquiry may be, certain problems are common to all research methods. These include the generalisability of findings: that is, the degree to which findings derived from one context or under one set of conditions can be assumed to apply in other settings or in other conditions (Evans, Packwood, Neill & Campbell, 1994; Shulman, 1988). Ethnographers feel that an in-depth study which gives accurate knowledge of one setting not markedly dissimilar from other relevant settings is likely to be generalisable in substantial degree to those other settings (Spindler, 1982). They also argue that it is better to have an in-depth, accurate knowledge of one setting than superfluous and possibly skewed or misleading information about isolated relationships in many settings. In other words, the results obtained by survey methods and upon which educational decision-making has often been based are ethnographically suspect because they may have been distorted by the fractionalisation of inquiry and by ignoring meaning shared by informants (Spindler, 1982).

Reliability addresses the issue of replicability. External reliability is concerned with whether or not the same constructs would be generated by

different researchers in similar settings (Merriam, 1998). Internal reliability asks whether researchers would match the constructs generated from a study in the same way as the original researcher (Lubeck, 1985; Stenhouse, 1982c). Ethnographic studies are conducted in natural settings and thus even the most rigorous attempts cannot replicate a study exactly as it occurred. Much is determined by unique circumstances and by the personalities of those involved at a given time and place. For these reasons, reliability may only be approached, rather than attained by ethnographers (Lubeck, 1985; Merriam, 1998).

Where ethnographic research cannot make strong claims with respect to reliability, validity is its great strength (Lubeck, 1985). Validity addresses the issue of accuracy: to what extent do the constructs generated reflect or represent empirical reality? Validity depends on purpose and the reader's point of view (Stake, 1988). Ethnographic research is valid to the reader to whom it gives an accurate and useful representation of the bounded system.

A further potential problem for the ethnographer is the issue of involvement in the issues, events, or situations under study (MacDonald & Walker, 1982; Rudduck, 1993; Sullivan, 1989; Wolcott, 1973). This is likely in education studies where researchers are generally very familiar with the setting. It is difficult for researchers to maintain an optimum distance from the teachers with whom they are working. Erlwanger (1975), for example, encountered a conflict between his role of researcher and that of helper. A dilemma often faced by researchers is how to maintain an objective, external perspective if the participants of the study accept the researcher as one of the group. Gilmore and Glatthorn (1982) claimed that the insider-outsider problem can be resolved simply by explaining that, by definition, good ethnography rests on insider-outsider collaboration, in which collaboration means that both parties share the work as well as the rewards of the effort. If a researcher believes that research with human subjects should not be

conducted without the consent and understanding of the subjects themselves, then an explicit style of research is appropriate. More covert strategies are often adopted by those who fear that the responses of subjects who understand the research in which they will be involved will be influenced by this knowledge (Stenhouse, 1982a). Such influence will, it is claimed, distort the data provided to the researcher and hence reduce the validity of the research. Whether this is a cogent argument or not must depend heavily on the research problem and on the style of interpretation to which the researcher aspires (Stenhouse, 1982a).

*Access to Data*

Whether the researcher chooses an explicit or a covert approach to educational research, the associated issue of access to data needs to be negotiated. Confidentiality of data should be assured early in the research project. This may, however, create difficulties later in relation to publication (MacDonald & Walker, 1982; Rudduck, 1993; Sullivan, 1989). Although it is critical that the anonymity of subjects is guaranteed, it is also important that readers of the research report feel a sense of identification with both the setting and with key figures (Wolcott, 1973). The audience should be able to distinguish data from the researcher's interpretation of data (MacDonald & Walker, 1982).

*Multiple Methods*

It is unlikely that any single methodology is sufficient to explore in depth a major area of inquiry. The selection of a single data collection technique is likely to be restrictive. To broaden the scope of the investigation and to ensure triangulation, multiple methods are recommended. Triangulation is the combination of different methodologies and theoretical perspectives in the study of the same

phenomena. While attempting to depict meaningful patterns of behaviour the researcher strives to triangulate data sources by seeking different perspectives of the same situation through observations, interviews, and written documentation obtained from different people in a given setting (Bogdan & Biklen, 1998; Glesne & Peshkin, 1992; Lubeck, 1985; Merriam, 1998). By utilising multiple observers, theories, methods, and data sources, researchers can hope to overcome the intrinsic bias that comes from single-method, single-observer, single-theory studies (Denzin, 1978).

The use of quantitative approaches to supplement qualitative research methods enables the researcher to enjoy the rewards of both numbers and words (Glesne & Peshkin, 1992). Because the positivist and interpretivist paradigms are based on different assumptions about the nature of the world they require different instruments and procedures to find the type of data desired. Rather than argue about which paradigms or methods are better Glesne and Peshkin (1992) have concluded that contemporary researchers see virtue in a variety of approaches and that this allows them to know and understand different things about the world.

### This Study: Methodological Choices

Discussions of quantitative and qualitative methodology often include value judgements related to the perceived superiority of a particular approach. Distinctions between methodologies are often artificially polarised and in reality a range of different approaches to, and methods of, research are included in each. Such is the case in this study. The researcher attempted to integrate both face-to-face interactions with individual teachers in interview situations with patterns obtained from a larger sample of early childhood teachers about their mathematics education professional development experiences.

## Data Collection Instruments

*Survey*

A self-administered mail survey was used in this study to obtain information about the backgrounds, the professional development involvement and the current mathematics teaching of early childhood teachers in the Northern Territory (Appendix A). Among the specific questions addressed by the survey were:

1. What formal qualifications and teaching experience do Northern Territory early childhood teachers have?
2. What have been the recent professional development experiences of Northern Territory early childhood teachers?
3. What are the characteristics of effective and ineffective professional development activities as perceived by Northern Territory early childhood teachers?
4. What resources and support services do Northern Territory early childhood teachers use in their mathematics teaching?
5. What are the interests and concerns of Northern Territory teachers in relation to mathematics education?

The data collected from the surveys was supported by additional data from the interviews.

From the total Northern Territory early childhood teaching population of approximately twelve hundred a stratified sample of two hundred teachers was surveyed in February, 1994. The stratification of the population into subgroups was to allow the researcher to choose a sample which represented various groups and patterns or characteristics in the desired proportions (Fink & Kosecoff, 1985). In this investigation it was considered necessary to ensure that the sampling included teachers from both large (more than twenty teachers) and small schools, from both urban and rural

schools, and from government and non-government schools in the proportions that these are found in the total population of Northern Territory primary schools. Allowance was made for a typical mail survey response of between fifty to sixty percent, and participants who did not respond within a month were replaced by teachers from a similar school. After an initial poor response to the first questionnaire distribution a further eighty questionnaires were mailed out. These were sent to a broad sample of schools to ensure that there was a representative sample of small and large, urban and rural schools.

The questionnaire (Appendix A) was modelled on one designed by Reynolds and Clark (1984) to identify the inservice needs of teachers and administrators in Western Australia. It was felt appropriate, however to include more open-ended questions in this investigation's survey than in the Reynolds and Clark survey. The reasons for these modifications were related to the smaller sample size and broader scope of this investigation.

When designing a survey the researcher should define clearly and completely the problem to be investigated. Jaeger (1988) claimed that if the research emphasis is clear then only relevant questions will be asked and needless questions will be avoided. He recommended that when planning a survey the researcher should start with the basic research questions, not with the questions that make up the survey instrument. Jaeger (1988) suggested that one strategy for defining research questions is to use a hierarchical approach, beginning with the broadest, most general questions, and ending with the most specific (Fink & Kosecoff, 1985; Jaeger, 1988). This approach was used in the development of the survey instrument for this study.

A survey is an appropriate research tool when the information that is required should come directly from the people involved. Mail surveys provide an economical method for obtaining background information from

a target population, they can preserve anonymity, and are convenient for the respondent (Fink & Kosecoff, 1985). In this study a survey was used for two purposes—to obtain statistical background information about the target population and to elicit opinions on several issues.

In accordance with the suggestions of Jaeger (1988) the survey was self-explanatory, attempted to convince respondents that they should complete it, and explained how answers should be furnished, what questions to answer, and where to send completed questionnaires (Appendices B & C). Stamped, self-addressed envelopes were included to facilitate the return of the surveys. Jaeger (1988) also suggested that pilot studies should be conducted in order to increase the reliability and validity of the survey instrument, to gain an idea of the time needed to complete the survey, to ensure the instructions are appropriate for the people being surveyed, and to enable ambiguities in questions to be removed. A pilot study was carried out at the end of 1993 (Appendix D). The pilot study, aimed to increase reliability, focused on the clarity of the questions, the general format, and the capacity of the questionnaire to generate a range of responses. Twenty early childhood teachers, known to the researcher, were selected for the pilot study. This decision was made in the belief that a higher level of constructive feedback would be received from such respondents. Fourteen of these twenty teachers responded and the only feedback received was positive and related to the creative nature of the final, open-ended question.

Ethics, privacy, and confidentiality are major concerns in relation to the use of surveys. Respondents in this study received a written explanation of the procedures to be followed and their purposes, a description of the risks and benefits, an offer to answer any enquiries, and a guarantee of confidentiality (Appendices B & C). They also received information relating to feedback. Access to some form of reporting of the

results of the survey is considered to be important in gaining respondents' trust (Fink & Kosecoff, 1985).

*Interviews*

Although a survey can provide background information on a substantial sample of a population, interviews can elicit more complex information and allow for clarification of perspectives and ideas. In this study four early childhood teachers were interviewed in depth. The sample came from survey respondents who indicated a willingness to be interviewed. Three of the interviewees were from Darwin and one was from a rural school in the north of the Northern Territory. Interviews were used to allow informants to talk reflectively about their mathematics education experiences. Of particular importance in terms of the data obtained from the interviews were teachers' perceptions of their own mathematics teaching and mathematics education professional development.

The interviews were structured to the extent that there were key open-ended questions (Appendix E). A trial of the process was conducted with two of the pilot survey respondents to gauge the time needed and the appropriateness of the questions. Conducting pilot interviews ensures that the structure of the interview meets the requirements of the research project, tests the logistics of the interview, and provides an opportunity to practise the social interactive skills necessary for the kind of interview chosen (Powney & Watts, 1987). The interviewees had already received a written explanation of the research with the questionnaire and approval and access had been acquired. Interviewees were given the opportunity to edit the transcripts of the interviews. Guarantees of confidentiality and anonymity were given in writing (Appendix F).

Stenhouse (1982c) claimed that interviewing is a favoured methodological tool in education research because the conditions of condensed fieldwork preclude classic participant observation. An objective of ethnographic research in education is to provide in interview the conditions which will help teachers to talk reflectively about their observations and experience. Ethnographers use interviews to enhance insight into a "total situation" (Powney & Watts, 1987). The interview is a personal record of an event by the individual experiencing it, told from that person's point of view. A number of advantages of conducting one-to-one interviews have been documented by researchers such as Fink and Kosecoff (1985), Powney and Watts (1987), and Stenhouse (1982a). They suggest, for example, that interviews are easy to manage, issues can be kept relatively confidential, and analysis is reasonably straightforward. Interviews, however, may not be the only source of data within a particular research design, as supplementary data may be obtained from observational field notes, questionnaires or documents (Powney & Watts, 1987).

The status of research often depends on the degree to which the methods and findings are open to public scrutiny and debate. Powney and Watts (1987) claimed that interviewing should be conducted and reported as rigorously as any other method if it is to be treated as a serious research method. They emphasised the importance of planning and conducting interviews within some theoretical framework where broad questions are defined and tentative hypotheses grow from data.

Powney and Watts (1987) have described two types of interviews: respondent interviews in which the interviewer retains control by structuring the interview and limiting the issues discussed, and informant interviews in which the goal is to gain some insight into the perceptions of a particular person (or persons) within the situation and the interviewer attempts to help the interviewee express concerns and interests without

feeling duly hampered. In this study informant interviews were employed. Woods (1986) claimed that trust, curiosity and unaffectedness are key elements required in interviewing. He stated that the relationship between the interviewer and the interviewee should transcend the research and promote a bond of friendship, a feeling of togetherness and joint pursuit of a common mission rising above personal egos.

Woods (1986) claimed that the form of interviews is important. Ethnographers are more likely to find the term "interview" inappropriate and to regard the exchanges as conversations or discussions implying a more two-way open-ended informal process. This may contribute to a potential therapeutic element in this kind of encounter. It provides a platform for people to speak their minds in a way, and in such detail that rarely occurs for the ordinary person. Interviewees can gain a sense of control and confidence if they are given a choice about the time and place of an interview. The less formal, the more relaxed, the less confrontational the interview the more likely teachers are to share their views. Inherent in the use of interviews is the danger of a self-fulfilling prophecy when an interviewer is intimately involved in the research design (Powney & Watts, 1987). As in all research, the researcher's role in conducting interviews needs to be made explicit in the description of the research design.

In addition to survey respondents a number of key informants were also interviewed. In this study the key informants were people, other than classroom teachers, who were involved in mathematics or early childhood education. Key informants can help to give perspective to the entire methodological front. They can be a source of large amounts of data, in a sense being proxy participants in areas inaccessible to the researcher (Woods, 1986). In the key informant interviews the interviewer used what Gardner (1976) described as a "funnel approach" where the informant is gently guided towards a topic on which the interviewer requires information. The

key informants in this investigation were selected because of their potential to provide background information on specific aspects of early childhood education, mathematics education or professional development in the Northern Territory (see Appendix G for interview questions). Table 3 lists the key informants and their links with the major areas of investigation.

Table 3

*Key Informants and Areas of Expertise/Interest*

| Key Informant | Expertise/Interest |
|---|---|
| Principal Education Officer | Curriculum projects<br>Teacher professional development |
| Project Officer (Mathematics) | Mathematics education projects |
| Former Principal Education Officer (Early Childhood) | Curriculum and projects<br>Teacher professional development |
| Project Officer (Early Childhood) | Teacher support and projects |
| Early Childhood Mathematics Project Coordinator | Early childhood mathematics<br>Professional development |
| President, Professional Association | Mathematics education<br>Professional development |

Interviews were audiotaped so that the full conversation was faithfully recorded. The interviewees, however, were able to retain ownership of the data on the tapes (Appendix H). Transcriptions were made from the audiotapes and were given to interviewees for checking. The transcripts were coded and data categorised in terms of its relationship to the major areas of investigation. The interview data were integrated with the data obtained from the survey and document collection.

*Selecting Informants*

Powney and Watts (1987) claimed that researchers should have two criteria in mind when endeavouring to find the best informants: the

informants should be sensitive to the area of concern and they should be willing to inform. Spradley (1980) considered that the minimum requirements for identifying the good informants for ethnographical studies were:

1. Informants should not be new to the situation unless that is the focus of the study;
2. The informants' status should be taken into account when analysing their contributions;
3. So that the researcher takes nothing for granted, the culture should be unfamiliar;
4. Informants should have adequate time;
5. Informants should be non-analytic. That is they should not try to make analyses in the terms they believe the researcher may be using, such as socio-economic status. (On the other hand, some analysis may be very helpful if informants use their own folk theory.) (p. 49)

Research in education is often conducted by people from within the field so it is not possible for the culture to be totally unfamiliar. This was the case in this study.

*Document Collection*

Documents were collected from four principal sources; the Northern Territory Department of Education, the Northern Territory Catholic Education Office, the Mathematics Teachers Association of the Northern Territory, and a sample of ten Northern Territory schools. A summary of the document collection is contained in Table 4. The document analysis provided quantitative data on the number, type, and frequency of mathematics education professional development activities in the Northern Territory in the past five years. It also yielded descriptive data related to the aims and organisation of mathematics education in the Northern Territory.

Table 4.

*Summary of Sources and Types of Documents Studied.*

| Source | Documents studied |
|---|---|
| Northern Territory Department of Education (NTDE) | Professional development program 1984-1994.<br>Professional development policy<br>Mathematics education policy statement.<br>Early childhood policy statement. |
| Catholic Education Office | As for NTDE. |
| Mathematics Teachers Association of the Northern Territory. | Aims<br>Program of activities 1984-1994.<br>Membership details 1984-1994. |

*Reporting*

A dilemma arises with respect to the reporting of ethnographic research. In order to make such reports accessible to others the data collected are usually summarised and simplified at various stages in the research process. In such summaries, however, the rich descriptions which form part of the original study and which evoke recognition by readers may be lost, thus diluting the power of the research itself. The conception of reality reflected in the research report is important. The use of triangulation will contribute to the presentation of multiple realities in the report.

Stoecker (1991) claimed that the research methods employed in contemporary ethnographic research provide a moral obligation to focus enough attention on the case to inform those who are living in it. Interviewees are asked to give not only their time but also something of themselves through their personal comments and views. Researchers have a moral obligation to provide something in return. By employing effective techniques, according to Stoecker (1991) researchers cannot help but have an

impact on those who live the case, and it behoves them to make their impact conscious and helpful.

The problem of compiling a research record, in the view of Stenhouse (1982c) is to attenuate and expose to criticism the political and academic bias of researchers as well as their personal biases, which are more easily detectable by traditional criticism. The aspiration is not to produce objective data, for that is impossible. Rather it is to produce subjective data whose subjectivity is sufficiently controlled to allow critical scrutiny.

Ethnographic research, like other modes of research, is sometimes perceived by teachers to be the purview of professionals who study subjects and settings and for whom the pay-off lies in publication for a research or policy-oriented audience (Gilmore & Glatthorn, 1982; MacDonald & Walker, 1982). The results of research need to reach practitioners. More seriously, the structure of the educational research establishment is such that practitioners often do not have a sense of their vested interest in research, nor does effective networking take place among teachers and administrators so they can share either the problems they face in common or the answers they have formulated. Too often, according to Gilmore and Glatthorn (1982) practitioners are seen as, and see themselves as, end points on a linear research model; either they are the subjects on the one extreme, or the consumers on the other. In both positions their role is that of passive object of the experts' attention.

MacDonald and Walker (1982) considered that the interpretations made in a research report are essentially the interpretations of the researcher who has sole responsibility for the final account and has the right to control the research work. MacDonald and Walker claimed that it is time for this right to be questioned and that the critical issues which emerge in this reappraisal can be posed quite simply:

> To whose needs and interests does the research respond? Who owns the data (the researcher, the subject, the sponsor)? Who has access to the data (Who is excluded or denied?)? What is the status of the researcher's interpretation of events, vis-a-vis the interpretations made by others (Who decides who tells the truth?)? What obligation does the researcher owe his subjects, his sponsors, his fellow professionals, others? Who is the research for? (p. 10)

Consideration of these questions prior to the commencement of data collection assisted in the compilation of information statements and research contracts which advised informants of their rights of access and editing in relation to the data.

# CHAPTER 5

# DOCUMENT AND QUESTIONNAIRE ANALYSIS

## Introduction

*Sources of Data*

In this chapter the results of data collected from three sources are presented in summary form. In the first section, related to the provision of teacher professional development in the Northern Territory, the data were drawn from interviews with key informants and from document analysis. Details of the data collection procedures have been included in Chapter 4. In the latter part of the chapter, data drawn from the responses to a questionnaire given to teachers (Appendix A) will be used to describe some characteristics of the teachers in the study and to present information related to their involvement in non-award and award professional development, their approaches to teaching mathematics and their suggestions for planning mathematics education professional development activities. Discussion arising from the data analysis will be presented in Chapter 7.

## Teacher Professional Development in the Northern Territory

*Professional Development Providers*

The major provider of teacher professional development in the Northern Territory is the Department of Education. The Department has utilised federal and territory government funds to provide professional support ranging from short-term courses of as little as a day, to paid study leave for periods of up to a year (N. McKenzie, personal communication, February 9, 1994). Because of the small size of the teaching and student populations in the Northern Territory many of the Department of Education's professional development activities and teacher support

services are also available to teachers in non-government schools. The major non-government system, the Catholic Education Office, has not conducted its own professional development program for ten years. Teachers in Catholic schools have, however, had some access to Department of Education professional development activities.

During the past decade additional professional development activities, mostly organised out of school hours, have been provided by professional associations. The membership fees of these associations have covered the costs associated with organising activities which have included workshops, seminars, sharing of resources and ideas, talks by visiting scholars and weekend conferences. Some activities have attracted funding from the Department of Education to enable teachers from all government schools in the Northern Territory to attend (Mathematics Teachers' Association of the Northern Territory, 1994). Recent initiatives such as the *Mathematics Teaching, Learning and Assessment Project* (*MaTLAP*) have involved collaboration between the Department of Education and professional associations (in this instance the Mathematics Teachers' Association of the Northern Territory). These initiatives were conducted during school time. A further collaboration involving the Top End Council of the Australian Reading Association, the English Teachers Association of the Northern Territory, the Northern Territory University and the Northern Territory Department of Education has enabled teachers to utilise their participation in a professional development activity as part of a tertiary award.

There are two higher education providers in the Northern Territory. Batchelor College offers award courses for Aboriginal students who plan to work in Aboriginal communities and the Northern Territory University offers award courses in law, arts, science, business and education similar to those offered by other Australian universities. The Northern Territory University's contribution to teacher professional development has been

principally organised through its preservice and inservice award courses. Other activities have included visiting scholar programs, curriculum workshops, seminar programs and specialist conferences such as that offered annually by the early childhood staff of the Faculty of Education. Individual staff members have also contributed to school-based professional development programs.

Other professional development providers have included a Darwin-based education supplier, Northern Territory School Supplies which, in both 1993 and 1994, conducted a program of activities for which teachers and parents paid to attend. These activities were presented by Northern Territory Department of Education personnel and Northern Territory University lecturers and were held on Saturday mornings. They differed from most other professional development activities in that parents were able to participate. Commercial interests such as text book publishers have also conducted workshops and activities in schools.

*Professional Development Activity in the Past Ten Years*

*Professional development trends.* The Northern Territory Department of Education's professional development offerings have changed considerably over the past decade. In 1985, for example, the inservice program reflected a national interest in computer education. A total of 155 professional development activities were offered by the Northern Territory Department of Education in 1985, and of these, 57 were related to computer education (Northern Territory Department of Education, 1985). In that year no specific mathematics education activities were offered, and no activities were targeted at early childhood teachers.

By 1989 the profile of programs offered reflected a change from central office initiation and conduct of the inservice program to the proposal and implementation of activities by interested groups and individuals in the

Northern Territory. Over 250 activities were offered throughout the Northern Territory in 1989, many being available in only one region. For example, *Mathematics and Language in Aboriginal Schools* and *Lively Strategies in Mathematics (Early Childhood)* were only offered in Alice Springs (Northern Territory Department of Education, 1989). At this time, the first of the more extended school-based mathematics education professional development programs, *Mathematics Inservice for the Northern Territory (MINT)* was offered. Other major mathematics education professional development followed in subsequent years (see Table 5.)

Table 5
*Summary of Northern Territory Department of Education Early Childhood Mathematics Education Professional Development Activities 1985 to 1994*

| Year | Activities | Focus |
|---|---|---|
| 1985 | Nil | |
| 1986–88 | Short-term, local courses | Interests, local needs |
| 1987 | *MCTP* | Early childhood mathematics |
| 1989–92 | *MINT* | Early childhood, primary mathematics |
| 1991–92 | *EMIC* | Early childhood mathematics |
| 1992–93 | *CENTS* | Calculator use in classrooms |
| 1993–94 | *MaTLAP* | Early childhood, primary and secondary mathematics |

*MCTP - Mathematics Curriculum and Teaching Project, MINT - Mathematics Inservice Network for the Northern Territory, EMIC - Early Mathematics Inservice Course, CENTS - Calculators and Estimation in Northern Territory Schools, MaTLAP - Mathematics Teaching, Learning and Assessment Project.*

By 1992 programs such as *MINT, Early Mathematics Inservice Course (EMIC)* and *Calculators and Estimation in Northern Territory Schools (CENTS)* dominated the mathematics education professional development offerings (Northern Territory Department of Education, 1992). By 1994 the

model for professional development provision had changed yet again. The Northern Territory Department of Education initiated some projects, such as the National Indonesian Language Curriculum Implementation, which were in accord with national or system priorities. Most professional development activities, however, were initiated by schools in consultation with Curriculum Advisory Support Unit Project officers (N. McKenzie, personal communication, February 9, 1994).

*The Curriculum Advisory Support Unit.* The Curriculum Advisory Support Unit was established in 1992 to assist teachers in schools on an ongoing basis. Attached to the unit are Project Officers with expertise in particular curriculum areas, who work independently, or collaboratively, on school-based, regional or central professional development projects initiated by schools, school principals' groups or professional associations (N. McKenzie, personal communication, February 9, 1994). School-based projects, in which schools identify their own goals and make a commitment to sustained involvement in a professional development project, are the major focus of the work of the Curriculum Advisory Support Unit.

In 1994 there were two Mathematics Project Officers and a new position was created for an Early Childhood Project Officer. Between 1991 and 1994 there had been no designated Early Childhood support staff in the Northern Territory Department of Education (M. Reidl, personal communication, June, 1993).

The Mathematics Teachers' Association of the Northern Territory (MTANT) has also contributed to mathematics education professional development in the past decade. Formed in 1984, the Association aims to provide services to improve the quality of mathematics teaching and learning in the Northern Territory (Mathematics Teachers' Association of the Northern Territory, 1994). The professional development activities organised by MTANT have included an annual two-day conference as well

as occasional lectures, seminars and workshops. In 1993 MTANT was involved in the trialling of Pattern, Order and Algebra workshops for the *Maths Works* program based on *A National Statement on Mathematics for Australian Schools* (Australian Education Council, 1991a) and in the development of the Mathematics Teaching, Learning and Assessment Project. Members of MTANT receive regular newsletters and materials from the Australian Association of Mathematics Teachers.

*Initiatives in Mathematics Education Professional Development*

*Mathematics Curriculum and Teaching Project (Early Childhood).* At the beginning of 1987 the Northern Territory Department of Education was funded under the national *Basic Learning in Primary Schools (BLIPS)* program to conduct a teacher development program for teachers of classes from Transition to Year 3. This program involved participants in the designing and trialling of mathematics activities which provided opportunities for children to generate more than one response, to move from the concrete to the abstract, and to record their mathematical discoveries in their own way (Crompton, 1987). The teachers involved in this project analysed various aspects of the teaching and learning process and documented the work done in their classrooms in a publication entitled *Children and Teachers Learning Together* (Crompton, 1987).

*Mathematics Inservice Network for the Territory (MINT).* In September, 1988 the Northern Territory Department of Education Mathematics Subject Area Committee endorsed a concept proposal for *Mathematics Inservice Network in the Territory* (*MINT*). This program was developed in response to a perceived need for a comprehensive professional development package which went beyond the one-day inservice course and aimed at long-term improvement of practice (Perrin, 1989). Professional development packages from other states were examined by senior

curriculum staff of the Northern Territory Department of Education and the best features were incorporated into *MINT*.

The aim of *MINT* was to provide participants with a theoretical framework and working knowledge from which they would be able to develop new exemplary materials, thereby bringing about long-term improvement in their classroom practice (Perrin, 1988). The course was designed to run over a ten-week period and participants were expected to trial exemplary materials between meetings. Facilitators conducted workshop sessions and offered professional support by responding to the individual needs of participants. An evaluation of the program was conducted three to six months after participants had completed the course and the results indicated that participants perceived positive outcomes for themselves and for the children with whom they worked.

*Calculators and Estimation in Northern Territory Schools (CENTS).* The *Calculators and Estimation in Northern Territory Schools* project began in 1992. It was structured along similar lines to the *MINT* program but aimed at enhancing primary teachers' confidence and teaching expertise in the use of calculators in the classroom.

*The Mathematics Teaching, Learning and Assessment Project (MaTLAP).* Following the release, in 1991, of *A National Statement on Mathematics for Australian Schools* (Australian Education Council, 1991a) the Australian Association of Mathematics Teachers, with funding provided by the Department of Employment, Education and Training, developed an information kit to stimulate discussion on significant areas of mathematics education in Australia. In the Northern Territory discussion relating to the *National Statement* led to a proposal for a professional development and community awareness program concerning mathematics teaching and learning.

The concept for the proposed program was developed during 1992 by the Mathematics Teachers' Association of the Northern Territory in consultation with personnel from the Northern Territory Department of Education, and reflected the need for professional development which would improve the quality of mathematics teaching and learning in Northern Territory schools (G. Gillman, personal communication, October, 1993). Some of the aims of the program were that it be developed within existing resources and that it should reflect the goals and principles of current mathematics curriculum in the Northern Territory, *A National Statement on Mathematics for Australian Schools* (Australian Education Council, 1991a) the nationally developed *Mathematics: A Curriculum Profile for Australian Schools* (Australian Education Council, 1994) and the DEET/AAMT professional development packages.

The *MaTLAP* program involved the training of school-based tutors to present a series of professional development sessions whereby participants were able to trial new teaching strategies and later to reflect, with peers, on their successes. Staff meetings and pupil-free days were to be used by staff to engage in professional development activities.

The program began in July, 1993 with a three-day tutor-training course, held in Darwin. Participants were then recalled in October of the same year to discuss the trialling of ideas and resources. The perceived strength of *MaTLAP*, according to Nulty (1993) lay in its utilisation of cooperative, collaborative teams of teachers, linked through networks based on geographical proximity or common interest.

### The Teachers in This Study: Some Characteristics

Before discussing the involvement of Northern Territory early childhood teachers in mathematics education professional development activities, the characteristics of the teachers involved in this research project

will be described. The statistics and figures presented in this chapter derive from the 1994 survey of early childhood teachers in the Northern Territory described in Chapter 4. The categories of data summarised in the remainder of the chapter are teacher background, non-award professional development, award professional development and mathematics teaching. The final section of the discussion in the chapter deals with teachers' perceptions of how professional development should be planned.

*Teacher Characteristics*

The age and gender composition of the sample shows that the majority of teachers who completed the questionnaire were more than thirty years old and that more than eighty percent were female (see Figure 4). Figure 5 shows that two thirds of the questionnaire respondents had more than ten years teaching experience.

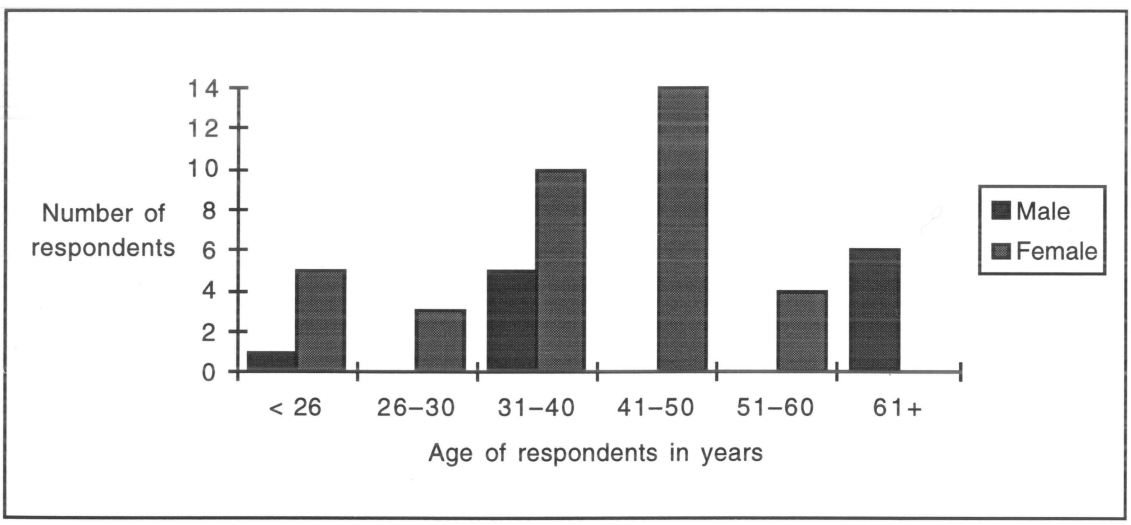



*Figure 4.* Questionnaire respondents by age and gender

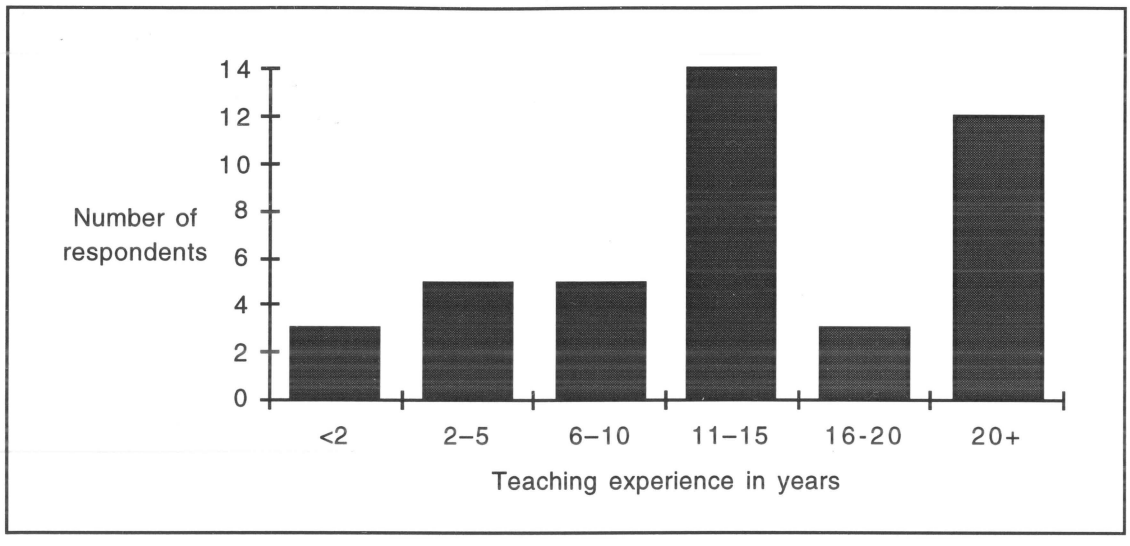



*Figure 5.* Questionnaire respondents by teaching experience in years

To facilitate discussion of the location of the teachers in this study, urban centres were taken to be towns or cities of more than 10 000 people. In the Northern Territory these are Darwin, Alice Springs and Katherine. As shown in Figure 6, approximately 42% of the questionnaire respondents in this study were in rural schools and these settings ranged from one-teacher schools on cattle stations to larger Community Education Centres. According to the Australian Education Council (1991b) 53% of Northern Territory schools and 24% of students are located in remote areas.

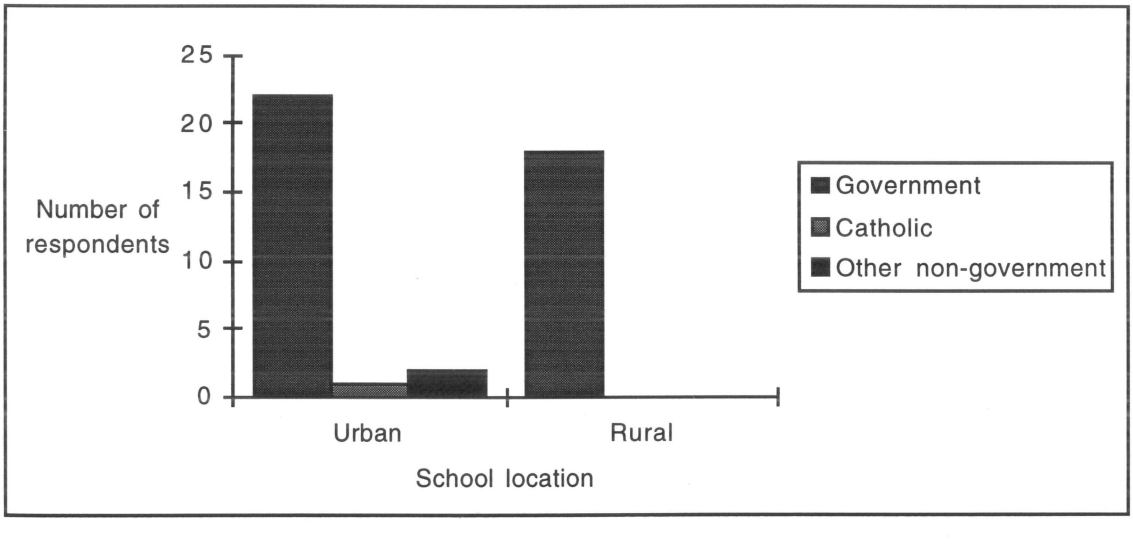



*Figure 6.* Questionnaire respondents by school system and location

*Initial and Post-initial Qualifications*

In the following discussion a pass degree is taken to be as a four-year degree program without a final overall graded result. That is, graduates have completed all requirements of the course but were not required to obtain grades at a particular level. An honours degree is taken to be a four-year program in which the graduate obtained results at an average of credit or better. A diploma course is one which has involved three years of study. A graduate diploma is a one year course of study which requires an entry point of a three-year diploma or a degree. In this study 28% of the teachers who responded had twenty or more years of teaching experience. Because most four-year programs were only introduced in the last 15 years, these teachers were less likely to have an initial four-year qualification than their less experienced colleagues. This is reflected in the data presented in Figures 7 and 8.

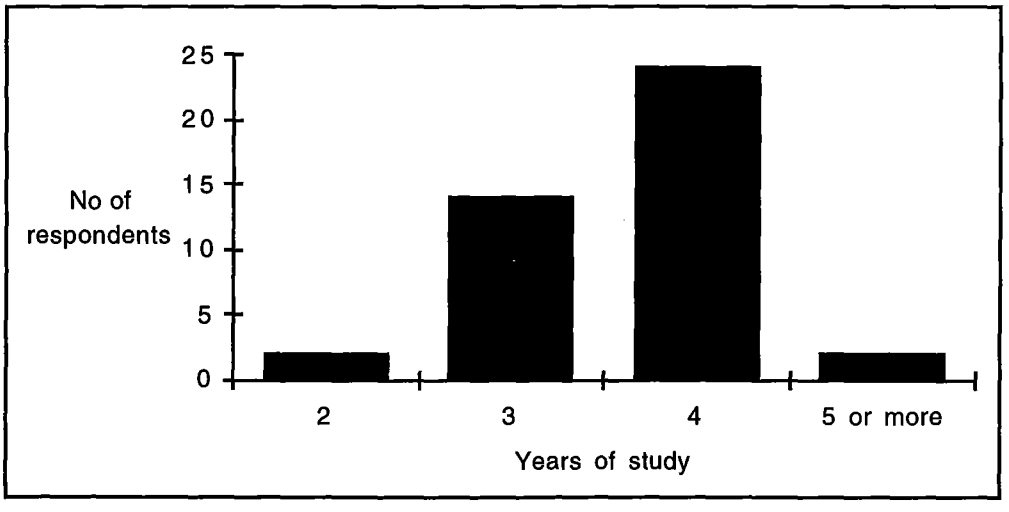



*Figure 7.* Questionnaire respondents by duration of initial qualification

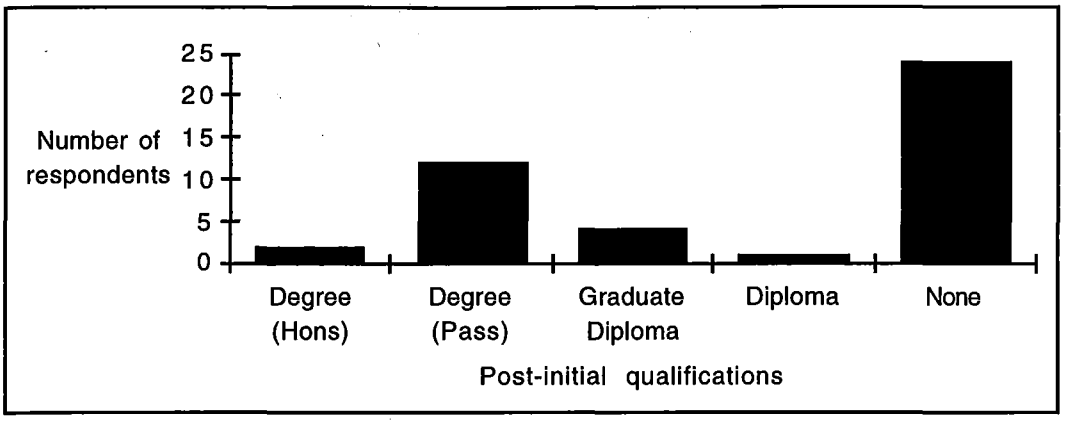



*Figure 8.* Questionnaire respondents by highest post-initial qualification

More than half of the teachers who completed the questionnaire had engaged in award courses since their initial qualification (see Figure 8). There were, however, two teachers in the sample with an initial two-year qualification and more than twenty years' teaching experience who had not completed any formal study other than their initial qualification.

Figure 9 shows that less than thirty percent of the teachers in this study were currently studying. This figure should be considered in relation to the fact that over sixty percent of the questionnaire respondents had completed an award course, either initial or post-initial, in the past five years.

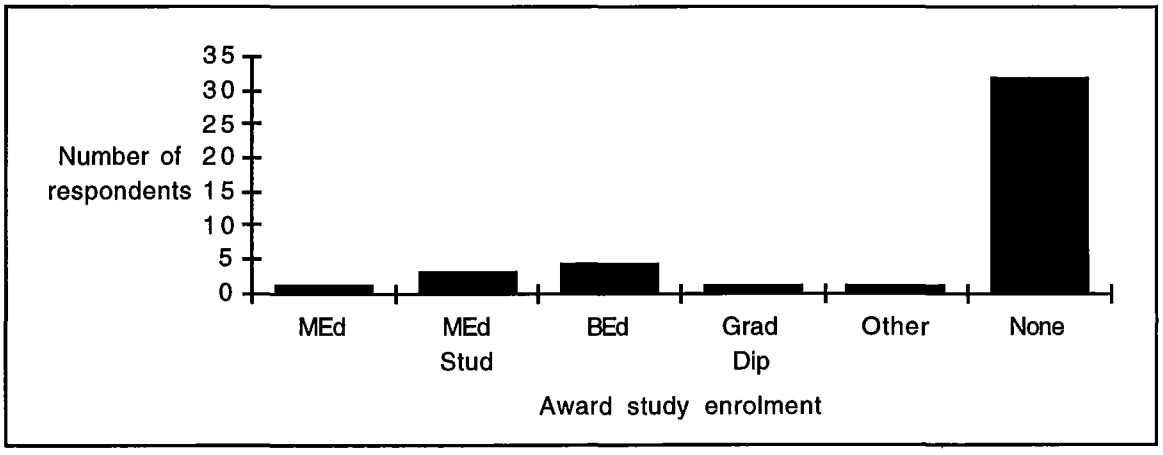
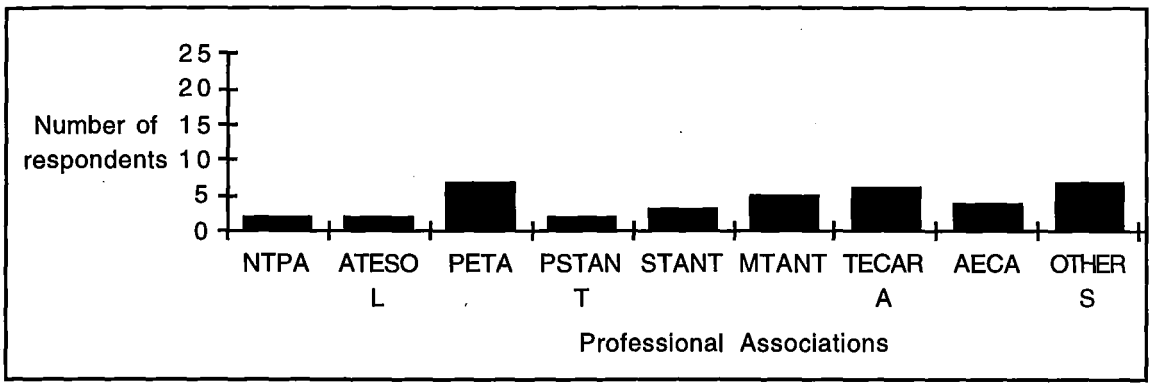



*Figure 9.* Questionnaire respondents by current participation in award courses

The participation of questionnaire respondents in professional associations is shown in Figure 10. Where respondents indicated membership of more than one organisation each membership was included in the data presented in Figure 10. All organisations listed were based in the Northern Territory and offered professional development activities except for the Primary English Teaching Association.




NTPA-Northern Territory Principals Association, ATESOL-Association for Teaching English as a Second Language, PETA-Primary English Teaching Association, PSTANT-Pre School Teachers Association of the Northern Territory, STANT-Science Teachers Association of the Northern Territory, MTANT-Mathematics Teachers Association of the Northern Territory, TECARA-Top End Council of the Australian Reading Association, AECA-Australian Early Childhood Association

*Figure 10* Questionnaire respondents by membership of professional associations

## Questionnaire Responses

The questionnaire was designed to obtain data related to a number of aspects of mathematics education professional development. These are discussed in turn in the latter part of this chapter, beginning with an analysis of responses to questions which had a focus on non-award professional development activities. This is followed by discussion of the data collected on teachers' participation in professional development

activities as part of award courses. Under the general theme of mathematics education, data obtained from the third part of the questionnaire have been presented. The data came from responses to questions which focused on teachers' perceptions and descriptions of their teaching of mathematics. The final section of the questionnaire was an open-ended question inviting suggestions for planning a professional development activity. The data have been analysed and presented using a framework developed by Crowther and Gaffney (1993).

## Non-award Mathematics Education Professional Development Activities

*Introduction*

In the section which follows the data discussed have been drawn from the sections of the questionnaire which pertained to professional development activities and which have not been undertaken as part of a formal tertiary award. These are referred to as non-award activities and include activities such as inservice courses, workshops, seminars, meetings of professional associations and professional reading. Data from responses to each questionnaire question will be discussed in turn.

*Question 1. List the mathematics education professional development activities in which you have been involved in the past twelve months.*

Responses to this question revealed that teachers had participated in a wide range of professional development activities. These have been categorised in Table 6 according to the organisation which conducted the activity.

Table 6
*Mathematics Education Professional Development Activities in Which Questionnaire Respondents had Participated in Previous Twelve Months*

| Provider | Activities |
|---|---|
| NT Department of Education | Introduction to *National Statement* |
| | *Calculators and Estimation in NT Schools* |
| | *Mathematics, Teaching and Learning Project* |
| | *Mathematics Inservice for the NT* |
| | *Early Mathematics Inservice Course* |
| | Mathematics inservice sessions |
| | Mathematics and science workshop |
| | Mathematics materials for Aboriginal schools |
| Professional association | Pattern, Order and Algebra Workshop |
| | *Mathsmeet* |
| School | Rigby Mathematics Programming |
| | Unit/teaching team meetings |
| | *Family Mathematics* |
| | Meetings about new curriculum |
| Commercial provider | Understanding base ten |
| | Patterning |

Many of the teachers in the questionnaire had participated in more than one activity during the previous year (see Table 7) but almost half of the questionnaire respondents reported that they had not participated in any mathematics education professional development activities in the previous year. Several of these respondents commented that, although they had not participated in any formally organised activities, they considered that informal discussion with colleagues and personal reading had contributed to their professional development. The status of informal activities and the place of workplace learning is discussed further in Chapter 6. One teacher had participated in five activities in the previous twelve months. This particular teacher had been involved in three departmental and two professional association activities.

Table 7
*Participation of Questionnaire Respondents in Non-award Mathematics Education Professional Development Activities in Previous Twelve Months*

| Number of Activities Attended | Frequency (N = 43) |
|---|---|
| None | 21 |
| 1 | 15 |
| 2 | 1 |
| 3 | 3 |
| 4 | 2 |
| 5 | 1 |
| More than 5 | 0 |

*Question 2. Which of these activities had positive outcomes for you? What made the activities successful?*

Table 8 shows that most activities in which questionnaire respondents had participated in the previous twelve months were considered to have had positive outcomes. Some respondents cited more than one activity as having positive outcomes. Over half of the respondents cited the long-term, system-wide activities supported by the Northern Territory Department of Education (*MINT, MaTLAP, CENTS* and *EMIC*) as having positive outcomes.

Table 8
*Frequency of Non-Award Mathematics Education Professional Development Activities Cited by Questionnaire Respondents as Having Positive Outcomes*

| Activity | Frequency (N = 21) |
|---|---|
| *MaTLAP* | 7 |
| *MINT* | 2 |
| *EMIC* | 2 |
| *CENTS* | 2 |
| Other activities | 12 |

When identifying factors which contributed to the success of mathematics education professional development activities attended in the

previous twelve months several respondents mentioned more than one factor. The frequency of these factors is summarised in Table 9.

Table 9
*Frequency of Factors Cited by Questionnaire Respondents as Contributing to the Success of Mathematics Education Professional Development Activities*

| Factor | Frequency (N = 21) |
|---|---|
| Sharing of ideas | 7 |
| Practical | 5 |
| Active involvement | 3 |
| Increased confidence | 3 |
| Support after activity | 3 |
| Trialling materials or ideas | 3 |
| Demonstrations of materials or teaching strategies | 3 |

*Question 3. Which of these activities was least successful for you? What factors contributed to the lack of success?*

Of the teachers who had participated in professional development activities less than half responded to this question. Those who did all cited a lack of relevance to their current teaching situation as the reason why that activity had been least successful for them personally. Respondents reported that factors contributing to relevance included consideration of the backgrounds of the participants, year level currently taught, teaching situations (for example, in Aboriginal schools) and presentation methods.

*Question 4. What has provided the motivation for your participation in mathematics education professional activities in the past three years? (For example, received funding, opportunity to meet other teachers, new curriculum documents, etc).*

Teachers cited a range of factors which motivated them to participate in professional development activities. These are summarised in Table 10.

Because some teachers mentioned several factors, the total number of responses shown in Table 10 is greater than the number of respondents.

Table 10
*Factors Cited by Questionnaire Respondents as Providing Motivation for Participation in Professional Development Activities*

| Factors | Frequency (N = 43) |
|---|---|
| Interest in/love of teaching mathematics | 10 |
| Opportunities to share ideas | 10 |
| New curriculum documents/development | 9 |
| Access to new information | 6 |
| School-based and organised activity | 6 |
| Need to boost confidence | 6 |
| Received funding and permission | 4 |
| Recommendation of colleagues | 3 |
| Availability | 2 |
| Wanted to follow up on professional reading | 1 |
| Gaining credit towards an award subject | 1 |
| Concerns in implementing activity-based mathematics | 1 |

*Question 5. Think back over all the mathematics education professional development activities you have experienced in your career. Briefly describe the one that, for you, had the most impact on your teaching, and comment on why you think this was the case.*

Over half of respondents cited system-wide, extended professional development activities such as *EMIC, MaTLAP, MINT* and MCTP as the mathematics education professional development activity which had the most impact on their teaching (see Table 11). Several respondents identified particular significant individuals and critical incidents in relation to professional development activities which had had the most impact on their teaching.

Table 11
*Mathematics Education Professional Development Activities Cited by Questionnaire Respondents as Having had the Most Impact on Their Teaching*

| Professional Development Activities | Frequency (N = 43) |
|---|---|
| *EMIC* | 14 |
| *MINT* | 6 |
| *MaTLAP* | 3 |
| MCTP | 1 |
| Other | 17 |
| Nil response | 2 |

The factors cited by questionnaire respondents as contributing to the impact of the activities listed in Table 11 are shown in Table 12. Some respondents noted several factors, so the total number of responses is greater than the number of respondents. Significant diversity is evident in the responses.

Table 12
*Factors Cited by Questionnaire Respondents as Contributing to the Impact of Professional Development Activities*

| Factors | Frequency (N = 43) |
|---|---|
| Practicality | 12 |
| Introduction to/use of resources | 9 |
| Personal benefit | 8 |
| Relevance | 7 |
| Organisation of professional development activity | 7 |
| Collegiality | 6 |
| Understanding of children's learning | 4 |
| Theory | 3 |
| Classroom organisation/planning | 1 |

*Factors Contributing to the Impact of Professional Development Activities*

Details of the factors listed in Table 12 were provided by many respondents. These details are summarised in the section which follows under headings related to each of the factors.

*Practicality.* The major example of the practicality of professional development activities, as described by respondents, was the opportunity to use the ideas, games and activities introduced during the professional development activity "the next day." Other statements relating to practicality included references to activity rather than theory, the use of familiar documents and resources, and an introduction to novel, but readily prepared, activities.

*Introduction to/use of resources.* Gaining information about resources was identified as a major contributing factor in terms of the impact of professional development activities (see Table 12). According to respondents, being introduced to new games and activities, especially those which have already been trialed by classroom teachers, contributed to a favourable view of a professional development activity. The impact of an activity was also enhanced by an introduction to the use of concrete materials, to interactive experiences utilising concrete materials and to new equipment and resources.

*Personal benefit.* Respondents reported a range of personal benefits which derived from their participation in professional development activities. One of the benefits cited was increased confidence and enthusiasm in relation to the teaching of mathematics. Several respondents claimed that fun and enjoyment relaxed and encouraged them. A further dimension of the boost to confidence which came from participation was the realisation that, after sharing experiences with other teachers, what was being done in one's own classroom was interesting to others. Other personal benefits, according to respondents, accrued from the matching of their professional experience with the philosophy and presentation of the activity attended.

*Relevance.* When discussing relevance respondents mentioned being able to try things in their own classrooms, application to their particular

teaching situations, relevance to the year level currently being taught and relevance to their own teaching competencies.

*Organisation.* Aspects of the organisation of professional development activities which respondents felt contributed to their impact included the duration and timing of the activities. Respondents claimed that a series of sessions, with gaps of several weeks between sessions, contributed to a more lasting involvement. Establishing a relaxed, informal atmosphere from the beginning was also important. In addition, respondents mentioned thorough preparation, professional presentation, involvement by presenters and a sequential, well-ordered format as factors which encouraged participants to become involved in professional development activities.

*Collegiality.* Interpersonal relationships were recognised by respondents as influential elements of professional development activities. Many commented on how they had learnt from colleagues or had gained from sharing or working with peers. Establishing networks was also considered to be valuable in terms of support for new endeavours.

*Understanding of children's learning.* Contained in the responses to Question 5 (see Table 12) which related to the understanding of children's learning were statements referring to the importance of children's own construction of mathematics, recognition of the need to appeal to both boys and girls, being reminded of the importance of involving children in active, relevant mathematics in early childhood, learning about ways to make teaching mathematics enjoyable and learning about the importance of problem solving.

*Theory.* Some respondents considered that exposure to theory had contributed to the impact of successful professional development activities. One teacher mentioned that it was essential to have an introduction to ideology, assessment and theoretical background before tackling practical issues. Another claimed that one of the benefits of inservice activities was

that they provided an opportunity to fill gaps in theory after practical experience.

*Classroom organisation and planning.* Respondents identified a number of aspects of classroom organisation which were discussed in successful professional development activities (see Table 9). These included incorporating open-ended activities in the classroom, learning how to incorporate more games into mathematics programs, setting up problem-solving and task centres, and organising the physical environment to facilitate the inclusion of more practical experiences.

*Question 6. Given sufficient funding and opportunity, what mathematics education professional development activities would you like to participate in at this stage of your career?*

Table 13 shows the professional development activities which respondents indicated were appropriate for them. Many respondents provided more than one example of a desired activity.

Table 13
*Professional Development Activities Cited by Questionnaire Respondents as Appropriate for Their Career Stage.*

| Professional Development Activities | Frequency (N = 43) |
|---|---|
| Sharing/discussion of ideas with other teachers | 17 |
| Activities and resources | 13 |
| Curriculum content | 12 |
| Organisation for teaching | 10 |
| Children's learning | 7 |
| *EMIC/MaTLAP/CENTS* revisited | 4 |
| Latest trends/curriculum update | 3 |
| Mix of theoretical and practical | 2 |

Time with peers ranked as the most preferred professional development activity of questionnaire respondents. Examples of collegial activities listed by respondents were discussing ideas with individuals or groups, sharing understandings and ideas, and observing in other classrooms. Establishing networks was also mentioned. Several teachers expressed a desire to help other teachers either through mentor-type relationships or through being involved as a presenter of professional development activities. One teacher stated that working with Aboriginal assistants would be of great benefit.

Over two-thirds of questionnaire respondents mentioned specific aspects of the mathematics curriculum as warranting attention through professional development. Several mentioned the need to understand the "big picture," and within it, the place of early childhood mathematics. Others expressed a need to understand where children would be going, in relation to mathematics, as they progressed through the school. Allied to this desire to gain a broader perspective was an expressed need to gain a better understanding of the place and use of curriculum documents and to refine programming skills. As early childhood teachers, many mentioned the importance of integration of mathematical ideas but felt assistance was needed in regard to integration of content areas (for example, number. space and measurement) within and across curriculum areas. Several teachers considered that teaching mathematics in early childhood settings, particularly when dealing with areas such as problem solving, needed to be dealt with in professional development activities specifically designed for early childhood teachers.

Few teachers articulated any want or need to participate in activities related to children's learning. Those who did suggested topics such as keeping track of understanding, examining the process of mathematical development in children, helping older children who were experiencing

difficulty, and girls and mathematics as areas they would like to explore further.

The desire to pursue aspects of teaching was described in terms of learning about the practical aspects of teaching mathematics, developing strategies for multi-age or multi-grade teaching (including working in small schools) and experiencing different approaches to teaching mathematics.

Specific aspects of curriculum content were identified by some teachers as the potential focus for professional development activities. Among the topics suggested were using calculators and computers, understanding place value, and working with two- and three-dimensional shapes. Reference to access and equity issues was made when respondents referred to their interest in teaching mathematics to Aboriginal and ESL children.

One-third of respondents wanted practical activities to be part of their professional development experiences at this stage of their careers. Some respondents articulated a desire for activities of the type presented in professional development programs such as *MaTLAP*, *CENTS*, *MINT* and *EMIC*. Several respondents considered it was worthwhile to work through activities which would be used later in the classroom, and to have opportunities to make problem-solving cards, activities and games. Evaluating resources was also mentioned as a valuable activity. Despite the small size of the sample there is a considerable range of responses. This highlights the complexities of attempting to provide for individual needs and interests when planning professional development.

### Mathematics Education Professional Development As Part Of An Award Course

For the purposes of this discussion award courses are taken to be those formal courses of study leading to a professional qualification and which would normally be undertaken in tertiary institutions.

*Question 1. List the mathematics education units/subjects completed in the past five years as part of an award.*

Less than one-third of the respondents had been enrolled, in the previous five years, in mathematics education studies as part of formal award courses. Table 14 shows the range of subjects studied and the institutions from which the subjects originated. Through cross-institutional enrolments, students at the Northern Territory University are able to enrol in subjects offered by other tertiary institutions.

Table 14
*Mathematics Units/Subjects Completed as Part of an Award*

| Type of Course | Subjects |
|---|---|
| Preservice | Graduate Diploma subjects (NTU) |
| | Diploma of Education subjects (NTU) |
| Inservice Bachelor | Transformational geometry (NTU) |
| | Mathematics Curriculum (Deakin) |
| | Literacy/Numeracy Skills in Early Childhood (SA) |
| | Trends in Childcare (Technology) (SA) |
| | Educational Measurement (NTU) |
| | Mathematics for Children with Special Needs |
| | Mathematics Skills for the Learning Disabled |
| Master of Education | Mathematics Teaching and Learning (Deakin) |

*Question 2. Which of these units/subjects had positive outcomes for you? What made the unit/subject successful?*

Several units/subjects were ones which had positive outcomes for the respondents. Most of the reasons given for this were related to the relevance and practicality of the subjects. Relevance was described in terms of personal and observed teaching situations, and choice and currency of content. Links to previous experience and the introduction of new theoretical perspectives such as constructivism were also noted by

respondents as important. Practicality was articulated as integration with other curriculum areas, practical ideas for use in the classroom, assessment and diagnostic techniques and work with children.

*Question 3. Which of these units/subjects was least successful for you? What factors contributed to the lack of success?*

Only two respondents answered this question. One claimed that a failure to see or learn about a constructivist approach in practice was a factor contributing to the lack of success in the subjects studied. The other respondent felt that too much time was devoted to free play with concrete materials at the expense of insights into activity-based mathematics.

*Question 4. What has provided the motivation for your participation in mathematics education units/subjects as part of award courses in the past five years? (For example, need to upgrade qualifications, desire for promotion, opportunity to meet other teachers, etc),*

Of the respondents to this question most were motivated, in terms of their enrolment in award course mathematics education, by external factors, as shown in Table 15.

Table 15
*Factors Cited by Questionnaire Respondents as Providing Motivation for Participation in Award Course Mathematics Education Units/Subjects*

| Factors | Frequency (N = 10) |
|---|---|
| Compulsory subject | 4 |
| Upgrading qualifications | 3 |
| Interest | 2 |
| Desire to upgrade curriculum knowledge | 1 |

*Question 5. Given sufficient time and opportunity, what further mathematics education units/subjects would you like to participate in as part of an award course.*

Some respondents identified more than one subject or topic as areas of study in which they would like to participate as part of an award course. The most frequently mentioned area was that of children's learning (see Table 16).

Table 16
*Units/Subjects Cited by Questionnaire Respondents as Desirable in Terms of Participation in Further Award Study*

| Factors | Frequency (N = 10) |
|---|---|
| Children's learning | 3 |
| Problem solving | 2 |
| Programming | 2 |
| Social justice perspectives and mathematics | 2 |
| Other | 4 |
| None | 2 |
| Don't know what's available | 2 |

**Mathematics Education**

In the third section of the questionnaire teacher-respondents were asked to provide information related to their teaching of mathematics. Their responses, analysed in the following pages, focus on the teachers' attitudes to teaching mathematics, their observations of children's learning and the sources of support for their teaching of mathematics.

*Question 1. Describe how you feel about your mathematics teaching.*

Table 17
*Frequency of Questionnaire Respondents' Attitudes to Mathematics Teaching*

| Attitude Category | Frequency (N = 43) |
|---|---|
| Positive | 28 |
| Negative | 8 |
| Mixed feelings | 7 |

Respondents' descriptions of how they feel about mathematics teaching are summarised in Table 17. To describe their positive feelings about teaching mathematics respondents referred to enjoyment, excitement, enthusiasm, confidence, feeling positive, and being challenged. Of the respondents whose responses were categorised as positive, approximately one-third qualified their responses by referring to subject matter, age group, personal wellbeing, and assessment. For example, "I am good on spatial relationships, adequate on number and poor on measurement."

Examples of responses which were categorised as "mixed feelings" were "It 'comes and goes'," and "ups and downs". Negative responses included comments such as "personally not as confident as I could be" and "often inadequate."

*Question 2. Describe a recent incident which has provided some insights into the way young children learn mathematics.*

In response to a question which asked for a description of an incident which provided insights into the way young children learn mathematics respondents provided details of the teaching/learning situation and teachers' and children's behaviours. These have been summarised in Table 18.

Table 18
*Summary of Questionnaire Respondents' Descriptions of Teaching Incidents which Provided Insights into Children's Learning*

| Attitude | Related Factors | Frequency (N = 43) |
|---|---|---|
| Positive | Related to children's learning | 26 |
| | Related to teacher planning | 18 |
| Negative | Related to children's learning | 2 |
| | Related to teacher planning | 2 |
| Nil response | | 5 |

The positive responses related to children's learning included children extending an idea, the links between concrete experiences and internalising an idea, children learning from each other, allowing children to solve problems for themselves, children observing other children, children using a range of strategies, children predicting, and the relevance of tasks.

The positive responses related to teacher planning included the importance of incorporating concrete, relevant and practical experiences into lessons, allowing time for children to extend ideas, allowing time to listen to children, integrating mathematics learning with other curriculum areas, guided play, incorporating opportunities for the teacher to encourage children to explain their thinking, teachers learning from one another and applying successful ideas, teacher-modelling strategies, the need to provide a variety of experiences, and planning to teach in context.

The negative responses related to children's learning included introducing topics too early, having too high an expectation of children and using an inappropriate format for children's mathematics experiences. The negative responses related to teacher planning made reference to insufficient use of concrete experiences and inappropriate presentation as contributing factors. This point is reiterated in the responses to Question 3. In these responses teachers' comments provide further support for the view that inappropriate planning is a significant factor in relation to children not learning significant mathematics.

*Question 3. Describe a mathematics teaching incident in which you felt that the children were not learning significant mathematics.*

In response to this question more than half of the 43 questionnaire respondents reported that the reason why children were not learning significant mathematics was related to teacher planning. The factors listed were broadly categorised as relating to the content basis of planning, the modes of lesson preparation chosen and assumptions about children's learning and progress. In relation to the content basis of planning teachers mentioned mathematics presented as just learning numbers and adherence to strict year level guidelines rather than following the children's experiences. The modes of presentation cited by teachers included the use of stencils, textbooks or board work, presenting topics in a boring way, lack of relevance to the children's world, poor choice of activities, using a "mental" maths test to try to assess a multiage group, beginning with worksheet instead of concrete experiences, and not catering for individual needs as contributing to children not learning significant mathematics. They also mentioned factors related to materials and equipment such as inappropriate choices of concrete materials, as well as inappropriate use of, and insufficient quantities of, equipment. Finally, questionnaire respondents commented on assumptions made about children's progress including expecting learning to emerge spontaneously from play, not picking up or recording difficulties, insufficient teacher supervision and feedback, making assumptions about children's learning and treating children as passive recipients of knowledge.

Other respondents cited factors related to children's learning in their descriptions of incidents in which the children were not learning significant mathematics. The factors cited included

- lack of motivation and transfer;

- little literacy or numeracy background;
- lack of parental involvement;
- children not understanding basic concepts;
- lack of confidence;
- rote learning without capacity to apply knowledge.

Of the 43 questionnaire respondents 12 did not respond to this question.

*Question 4. Describe the way in which you plan mathematics activities.*

Questionnaire respondents reported a diverse range of approaches to planning for mathematics in the classroom. The different approaches included the periods for which plans were made: whole year overviews, term planning, weekly and daily planning, and the basis of the plans (the Western Australian syllabus — the recommended syllabus document in the Northern Territory), text books, topics or children's interests. Table 19 lists the items mentioned by respondents in relation to their planning.

Table 19
*Items Cited by Questionnaire Respondents in Relation to Planning Mathematics*

| Planning Items | Frequency (N = 43) |
|---|---|
| Concrete materials | 12 |
| Integrated approach | 9 |
| WA Syllabus | 7 |
| Play | 7 |
| Strands | 6 |
| Problem solving | 6 |
| Games | 5 |
| Children's interests/incidental experiences | 3 |
| Start with concepts | 3 |
| Written activities | 3 |
| Other | 4 |
| No planning done | 1 |

*Question 5. List the support services which are available to assist you with your mathematics teaching. Comment on the access you have to these services.*

School-based support services were the most frequently cited sources of support for mathematics teaching according to respondents (see Table 20). School-based support included contact with the curriculum head or team, colleagues, project tutors, senior teachers, the principal and the librarian. Respondents reported that Departmental support came from project officers and involvement with special projects such as *MaTLAP*.

Table 20
*Support Services Cited by Questionnaire Respondents as Available for Assistance with Mathematics Teaching*

| Source of Support | Frequency (N = 43) |
|---|---|
| School-based | 27 |
| Department of Education | 20 |
| Teachers at other schools | 3 |
| Mathematics Teachers Association | 3 |
| Other | 5 |
| Not aware of any services | 3 |

**Planning Professional Development**

The final section of the questionnaire for teachers sought respondents' ideas about planning and implementing a mathematics education professional development activity for early childhood teachers. The question, which follows, was open-ended and so allowed for a wide range of responses.

*Imagine that you have been seconded to a Mathematics Resource Centre. You have been invited to plan a three day professional development activity in Darwin for fifteen early childhood teachers from bush schools,*

*large urban schools and preschools. How would you plan a program for these teachers? What would you include in the program?*

The professional development planning activity contained in this question yielded a great deal of narrative text. In order to present the data and analysis in a form which enabled readers to identify the predominant interests and concerns of respondents' responses were organised and summarised in relation to Crowther and Gaffney's (1993) characteristics of best practice in professional development. The general structure for the presentation of the data obtained from the open-ended question was based on work by Sullivan and Mousley (1994). The fidelity of respondents' words has been maintained and the analysis is the way in which these were grouped. The responses were categorised according to the following major components of professional development:

Planning

Implementation

Facilitation

Application

The frequency with which responses were coded under each category is presented in Table 21. The quantitative presentation is not to enable comparison of the components but to provide an indication of the relative importance of the various components of professional development to the questionnaire respondents.

Table 21
*Frequency of Response for Each Professional Development Component*

| Component | Frequency (N = 271) |
|---|---|
| Planning | 40 |
| Implementation | 194 |
| Facilitation | 22 |
| Application | 15 |

Crowther and Gaffney (1993) identified characteristics of best practice in relation to the four components. Table 21 provides a summary of the frequency of responses related to the characteristics of each component and for each characteristic a sample of illustrative comments is presented. The comments are presented in the words of respondents.

*Characteristics of planning.* The frequency of responses given for each of the characteristics of planning is presented in Table 22. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 22
*Frequency of Responses for Each Characteristic of Professional Development Planning Factor*

| Planning characteristics | Frequency (N = 40) |
|---|---|
| Needs-based | 11 |
| Preparation | 9 |
| Participant commitment | 7 |
| Social justice and equity | 6 |
| Relevance | 3 |
| Collaborative planning | 2 |
| Linkages between needs | 1 |
| Choice and flexibility | 1 |

Each of the characteristics of planning listed in Table 22 will be illustrated in the following section with examples of comments taken from the responses to the open-ended question in the questionnaire.

The notion of *needs-based* professional development was used to refer to the identification and acknowledgement of the needs of participants. Illustrative comments;

- *I would do an early questionnaire of who wants what including strengths and weaknesses prior or planning.*
- *I would plan a discussion to ascertain the needs of the group.*

*Preparation* was taken to be action undertaken prior to the implementation of professional development activities. Illustrative comments;

- *I would get together some bush school resources.*
- *I would advertise and organise venues, timetable, program.*

*Participant commitment* was interpreted as a requirement for teachers to be involved beyond just attending professional development activities. Illustrative comments;

- *The most powerful strategy for professional development is to instil confidence in the participants and encourage them to share "their good teaching strategies."*
- *During the workshop I would attempt to inspire commitment to return to their [teachers'] sections keen to discuss programming or some other pertinent issue.*

*Social justice and equity* refer to accessibility to all teachers. Illustrative comments;

- *I would probably have a session for each group of teachers—bush, urban, rural and preschool.*
- *I would have a lecture or workshop on "How to present mathematical concepts to children with minimal understanding of the English language".*

*Relevance* was interpreted as the relationship to participants' contexts and practice. Illustrative comments;

- *I would provide plenty of opportunity for sharing of concerns and ideas from their [the teachers'] classrooms.*
- *If possible I would visit each [teacher] to see them in action in maths to see their children and how they operate.*

*Collaborative planning* was taken to mean involvement in planning by more than one professional development stakeholder. For the purposes of

this study it included collaboration among teachers, parents, the community and other outside agencies. Illustrative comment;

- *I would ask teachers what they need and select from the stated needs the types of materials to be demonstrated.*

*Linkages between needs* referred to the capacity of professional development to address needs at different levels such as individual, school and system. Illustrative comment;

- *I would try to link the needs of various groups (eg Aboriginal, preschool) and address the big issues.*

*Choice* of professional development experiences means that teachers are able to select experiences relevant to their personal and contextual needs. *Flexibility* referred to the accommodation of the needs of individual teachers. Illustrative comment;

- *I would try to collect a lot of different resources—videos of good practice in action, books, games, worksheets.*

*Characteristics of implementation.* The frequency of responses given for each of the characteristics of implementation is presented in Table 23. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 23
*Frequency of Responses for Each Characteristic of Professional Development Implementation*

| Implementation characteristics | Frequency (N = 194) |
|---|---|
| Active engagement | 54 |
| Balance of curriculum and pedagogy | 37 |
| Balance of theory, research and practice | 35 |
| Modelling of exemplary practice | 23 |
| Application of adult learning theory | 20 |
| Interactive action research | 9 |
| Effective use of time | 9 |
| Sequencing and spacing of program components | 4 |
| Reflection time | 3 |

*Active engagement* was taken to mean the inclusion of experiences which actively involve participants and the participants' responses to these. Illustrative comments;

- *You need plenty of "hands on time" for teachers to play and use equipment.*
- *Less talk (ie lecturing) and more hands on and sharing of experiences.*

*A balance of curriculum and pedagogy* refers to the linking of curriculum and teaching practices. Illustrative comments;

- *I would plan a series of hands-on activities then draw out the mathematical concepts involved.*
- *Plan a workshop in one area of mathematics where you fit in purposeful activities rather than textbook maths.*

*A balance of theory, research and practice* has been taken to indicate a relationship between the skills to be developed and theoretical underpinnings. Illustrative comments;

- *Actually plan a unit of work where you take into account theoretical aspects such as children's learning and then develop and produce support materials.*
- *I would have a session where the teachers have hands on experience then a short talk with the research back up for what they have done.*

*Modelling of exemplary practice* referred to opportunities for participants to observe other professionals in action. Illustrative comments;

- *I would include in the professional development activity visits to observe first hand master maths teachers in action.*
- *Visit good practitioners in action.*

*Application of adult learning theory* implied recognition of the expertise and experience of participants. Illustrative comments;

- *MOST IMPORTANTLY I would try to boost their [the teachers'] morale and confidence as maths teachers* [original emphasis].
- *People learn best if they do it themselves.*

*Interactive action research* referred to the potential for authentic ownership, networking and educational knowledge building. Illustrative comments;

- *Break up into groups for planning together units of work which can be used straight away in their classrooms.*
- *Ask each [teacher] to specify what changes will be made to her classroom and give time for each to plan a particular point of interest to be tried out.*

*Effective use of time* implied effective management of the time available. Illustrative comments;

- *Many early childhood teachers would benefit from merely interacting with each other in an environment for from daily pressure.*
- *Whole group forums need focus questions or they're a total waste of time*

*Sequencing and spacing of program components* referred to the timeline for the implementation of professional development activities. Illustrative comments;

- *Have a balance of hands on and talk sessions.*
- *Send people off to do things in their classroom. then report back after a few weeks*

*Reflection time* was a reference to the allocation of time for participants to reflect upon implications for their professional practice. Illustrative comments;

- *At the end of each day I would get the group to reflect on what they'd done.*
- *After visits to schools we would have reflection, evaluation of what was seen.*

*Characteristics of facilitation.* The frequency of responses given for each of the characteristics of facilitation is presented in Table 24. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 24
*Frequency of Responses for Each Characteristic of Professional Development Facilitation*

| Facilitation characteristics | Frequency (N = 22) |
|---|---|
| Resourcing | 13 |
| Facilitator expertise | 4 |
| Facilitative networking | 4 |
| Environmental quality | 1 |
| School executive support | 0 |

*Resourcing* has been defined as the provision of appropriate support and materials. Illustrative comments;

- *Make teachers aware of all the available support services and resources.*
- *Develop activity containers to take back to the school as a resource.*

*Facilitator expertise* referred to the knowledge and practical experience of personnel leading professional development activities. Illustrative comments;

- *Guest speakers should be able to address some of the needs of the group.*
- *I'd make sure that the guest speakers have a varied approach, from each other, to teaching mathematics.*

The opportunity to share ideas with other teachers has been referred to as *facilitative networking*. Illustrative comments;

- *Finish by establishing a network so teachers may support each other back in the classroom.*
- *Group the teachers together according to location and need.*

The *environmental quality* of professional development activities refers to an environment which is conducive to productivity and collegiality. Illustrative phrase:

- *I would get teachers to work in groups to plan units of work.*

*Characteristics of application.* The frequency of responses given for each of the characteristics of application is presented in Table 25. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 25
*Frequency of Responses for Each Characteristic of Professional Development Application*

| Application characteristics | Frequency (N = 15) |
|---|---|
| Follow-up | 9 |
| Practicality | 5 |
| Sense of ownership | 1 |
| Institutionalised teamwork | 0 |
| Transferability of learning | 0 |
| Rewards | 0 |
| Demonstrated accountability | 0 |

*Follow-up* has been interpreted as professional development experiences which extend beyond a single "one-off" activity. Illustrative comments;

- *Most inservice fails because of lack of follow up and support* [original emphasis].
- *I would arrange a time (say a month on) where we could get together to share ideas and see how new ideas developed.*

*Practicality* refers to the extent to which the knowledge and skills gained in professional development activities can be applied in practice. Illustrative comments;

- *I'd have maths materials you could make.*
- *Teach people how to read the syllabus.*

A *sense of ownership* has been used to describe the empowerment which motivates teachers to continue to explore and refine their ideas and practice. Illustrative comments;

- *Where possible I would support teachers to meet in clusters to support each other during the classroom research part of the project.*

**Summary Of Document and Questionnaire Data**

This chapter began with a review of the provision of mathematics education professional development activities in the Northern Territory in the period from 1985 to 1994. The data presented was based on analysis of relevant documents from the Northern Territory Department of Education, professional associations and personnel involved in the organisation of professional development during the period studied.

The remainder of the chapter contained the results of the analysis of a questionnaire completed by early childhood teachers in 1994. The data presented is related to the teachers' backgrounds, educational qualifications, participation in professional development activities and attitudes and interests in relation to mathematics teaching. The teacher respondents also provided suggestions for the effective planning and implementation of mathematics education professional development activities. In the following chapter additional data, derived from interviews with key informants and a selection of the teachers who completed the questionnaire,

are summarised. A discussion of the results of all data and their implications is the focus of Chapter 7.

# CHAPTER 6

# ANALYSIS OF INTERVIEWS

## Introduction

*Sources of Data*

The data presented in this chapter were drawn from interviews which sought to supplement data obtained from the questionnaire, the results of which are presented in the previous chapter. There were two categories of interviewees; key informants and classroom teachers. The key informants were individuals involved in the organisation of professional development in the Northern Territory. The classroom teacher interviewees were selected randomly from questionnaire respondents who indicated a willingness to be interviewed. Details of the data collection procedures have been included in Chapter 4.

In the first section of Chapter 6, in which the interview responses of key informants are summarised, the data have been categorised in terms of four major components of professional development. These components are planning, implementation, facilitation and application and have been drawn from the work of Crowther and Gaffney (1993). In the latter part of the chapter, data drawn from the classroom teacher interviews are presented in summary form in relation to teaching mathematics and professional development. Discussion arising from the analysis of the interview data is presented in Chapter 7.

## Key Informant Interviews

*The Key Informants*

The six key informants included in this study were selected because of their past or current involvement in the organisation of teacher professional development in the Northern Territory. They were:

- the Principal Education Officer of the Northern Territory Department of Education's Curriculum Advisory Support Unit;
- the former Principal Education Officer Early Childhood (The position was abolished at the end of 1993.);
- a Northern Territory Department of Education Early Childhood Project Officer;
- a Northern Territory Department of Education Mathematics Project Officer;
- the Coordinator of a BLIPS-funded early childhood mathematics education professional development project;
- the president of a mathematics education professional association.

The roles and responsibilities of the key informants described in this chapter relate to the time of interviewing which was 1994.

*Professional Development Themes*

The unstructured interviews conducted with the key informants yielded a large number of responses. In order to present the interview data and analysis in a form which should help readers to identify the predominant interests and concerns of interviewees, responses have been organised and summarised in the same way as the final question of the questionnaire. Thus, Crowther and Gaffney's (1993) characteristics of best practice in professional development were used as the basis for analysis. The general structure for the interview data presentation was based on Sullivan and Mousley's (1994) work. The fidelity of interviewees' words

has been maintained. The frequency with which responses were coded under each professional development component is presented in Table 26. The quantitative presentation was undertaken to provide an indication of the relative importance of each component of professional development to the interviewees, rather than to suggest a comparison of components.

Table 26
*Frequency of Key Informants' Responses for Each Professional Development Component*

| Component | Frequency (N = 1108) |
|---|---|
| Planning | 349 |
| Implementation | 186 |
| Facilitation | 359 |
| Application | 214 |

Crowther and Gaffney (1993) identified characteristics of best practice in relation to the four professional development components which are listed in Table 26. The frequency of key responses which can be associated with the characteristics of each component is shown in Tables 27, 28, 29 and 30.

*Key informants' responses: Characteristics of planning.* The frequency of responses given for each of the planning factors is presented in Table 27. Illustrative comments for each of the characteristics follow the table.

Table 27

*Frequency of Key Informant Responses for Each Professional Development Planning Factor*

| Planning factors | Frequency (N = 349) |
|---|---|
| Needs-based | 101 |
| Participant commitment | 61 |
| Collaborative planning | 59 |
| Linkages between needs | 29 |
| Relevance | 26 |
| Social justice and equity | 26 |
| Clarity | 18 |
| Preparation | 17 |
| Choice and flexibility | 12 |

The notion of *needs-based* professional development was used to refer to the identification and acknowledgement of the needs of participants. Illustrative comments include the following:

- *There's a real crisis in Aboriginal schools with young inexperienced teachers having no idea where to start with five year old Aboriginal children.*
- *The determination [for inservice] now though is based on assessment of teachers' needs from working with them ...*
- *They're [teachers] very concerned about covering the curriculum.*
- *I think the most important thing is to give people an opportunity to say "I would like to do something about this aspect of my progress."*

*Participant commitment* was interpreted as a requirement for teachers to be involved beyond just attending professional development activities. Illustrative comments;

- *There's three commitments that they make: one is to try something new...*

- *... and make sure people have to contribute to be part of it. And they were people who were prepared to then take a leadership role in their schools when they'd had a go at it [action research].*
- *... people have to have voluntarily identified that they want to be involved.*
- *But I would never want to have a project where people were forced to go.*

*Collaborative planning* was taken to mean involvement in planning by more than one professional development stakeholder. For the purposes of this study it includes collaboration among teachers, parents, the community and other outside agencies. Illustrative comments;

- *... so we tend to prefer to have a set of teachers in a school make a commitment to professional development.*
- *And then, if that's the way we want to go, let's then go and negotiate with the presenters.*
- *The teachers in schools are getting together with the preschool teachers to get inservices up.*
- *I wrote to Principals and asked if the early childhood coordinators could talk to the teachers and find out the sorts of things they want to know about.*

*Linkages between needs* referred to the capacity of professional development to address needs at different levels such as individual, school and system. Illustrative comments;

- *... so those teachers may be able to go across to other schools and work with other teachers.*
- *We still hold central inservices programs which somebody has determined are necessary.*

- *There is always the opportunity for the [Northern Territory] Education Department to direct a project in an area that should be created in a Departmental or national priority.*
- *... but the project officer generally very quickly points out that if you know there are other people interested, invite them along.*

*Relevance* was interpreted as the relationship of professional development to participants' contexts and practice. Illustrative comments;

- *... and we were focussing on early childhood, ... and he said "Look, this is just too far out of what I already know."*
- *None of the curriculum materials help them [teachers in Aboriginal schools] because they're really based on white middle class kids.*
- *Those teachers have to work very hard to seek out inservices specific to early childhood.*
- *I think this year the department has just realised the need for more early childhood emphasis.*

*Social justice and equity* refers to accessibility of professional development to all teachers. Illustrative comments;

- *... it had to be a Territory-wide project.*
- *... we wanted somebody from each region.*
- *... we could start to isolate schools that never call on the services of, not just the Curriculum Advisory Support Unit but of other support networks within the Department.*
- *We can talk about all sorts of professional development but it's always Darwin-specific or Alice Springs.*

*Clarity* refers to clear definition of goals and outcomes in professional development activities. Illustrative comments;

- *... some schools aren't particularly clear on how they're going to achieve their goals in the curriculum area.*

- *... some principals weren't explicit in their explanations about why people were selected [to attend a professional development activity].*
- *... and when the project was starting it was really airy-fairy sort of stuff, you know, you couldn't get a grip on it...*
- *... there was a real focus to this project: "This is not just about kids learning, it's about your learning."*

*Preparation* was taken to be action undertaken prior to the implementation of professional development activities. Illustrative comments;

- *So they've been grappling with what the project's about and why, but looking at what outcomes they want to achieve by the end of the project.*
- *... getting people involved has something to do with the careful planning of the professional development sessions ...*
- *So there was pre-planning before the day could even occur.*
- *... they were willing to put in the time and effort to prepare for the program.*

*Choice* of professional development experiences means that teachers are able to select experiences relevant to their personal and contextual needs. Illustrative comments;

- *... the professional development section of the department puts out a comprehensive list of the inservices that are available.*
- *Assisting schools can be through a range of professional development models.*
- *... one to one consultancies can be used.*
- *English has been a priority so there wasn't a lot of room for other major inservices.*

*Flexibility* refers to the accommodation of professional development activities to the needs of individual teachers. Illustrative comments;

- *... even though the program had a structure there was a lot of room for teachers to negotiate which way it went.*
- *... and so they [teachers] felt quite at liberty to say to the people presenting, "Well, look. We don't really want to do this, but we find this part more valuable."*
- *... just making sure people can have input, it's not just fixed.*
- *... we could have run with a project working with parents.*

*Key informants' responses: Characteristics of implementation.* The frequency of responses given for each of the characteristics of implementation is presented in Table 28. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 28
*Frequency of Key Informant Responses for Each Characteristic of Professional Development Implementation*

| Implementation characteristics | Frequency (N = 186) |
|---|---|
| Active engagement | 34 |
| Interactive action research | 32 |
| Balance of curriculum and pedagogy | 28 |
| Balance of theory, research and practice | 26 |
| Application of adult learning theory | 23 |
| Sequencing and spacing of program components | 16 |
| Reflection time | 10 |
| Modelling of exemplary practice | 10 |
| Effective use of time | 7 |

*Active engagement* was taken to mean the inclusion of experiences in professional development which actively involve participants and the participants' responses to these. Illustrative comments;

- *... one school looked at using the learning model to become more efficient in their programming.*
- *They've [teachers] got to think and they've got to relate it to themselves.*
- *And some [teachers] were quite negative at the beginning, sitting back with their arms crossed and that sort of stuff.*
- *It takes up so much energy and time, and commitment.*

*Interactive action research* refers to the potential of professional development for authentic ownership, networking and educational knowledge building. Illustrative comments;

- *... and this is where I'm encouraging that network within the school.*
- *So by the end of term everybody will have had that experience.*
- *So they would go back and try a new activity in their classroom.*
- *... so they did a lot of workshops with the teachers in their school.*

*A balance of curriculum and pedagogy* refers to the linking of curriculum and teaching practices in professional development offerings. Illustrative comments;

- *It's not just the teacher saying "I've got the knowledge and I'm going to give it to you and I'm going to write it on the board and if you don't want to learn it that's tough."*
- *People need more work on how to get what the process is, where do the curriculum documents come from and how do I get from there to what I have to do?*
- *We go through the [curriculum] overviews and the units of work and the day book and the timetable and see how it all fits together.*

- *We emphasise that children do learn better when they're interacting and making connections between different curriculum areas.*

*A balance of theory, research and practice* is taken to indicate a relationship between the skills to be developed through professional development and theoretical underpinnings. Illustrative comments;

- *I think there needs to be more emphasis on teachers knowing where they're coming from and why they're doing things and a little bit more, a solid grounding in the theory of how kids learn.*
- *I'm working with a group of preschool teachers this week and they said " We don't want any b...s.... We want the nitty gritty."*
- *And teachers often go from the practical to the theory behind it.*
- *... I know a lot of people are concerned about terminology.*

*Application of adult learning theory* implies recognition of the expertise and experience of participants involved in professional development activities. Illustrative comments;

- *I got the project officers to start thinking about ways of dealing with these sorts of people—the rattlers, the clockwatchers, the knitters, and then you've got the persistent questioner, the aggressive questioner, the interrupter, the know-all, all those sorts of things.*
- *The big difference is you're working with adults.*
- *When the people came in they were a very diverse group; and some were very quiet and some were quite happy to talk about what they'd been doing.*
- *... some people, perhaps the ones who've taught longer ... were much more cautious, they had to take smaller steps ...*

*Sequencing and spacing of program components* refers to the timeline for the implementation of professional development activities. Illustrative comments;

- *You do actually need a break when you just talk to other people or think yourself.*
- *That's been the problem in the past with professional development things, I think—they've been one day.*
- *They went away and tried things ... and actually did some report-backs in the second workshop.*
- *We then met in little hub groups over that semester so that they could actually come back together and have the support group ...*

*Reflection time* was taken to mean allowance for both structured and unstructured time for participants to reflect upon implications of professional development for their professional practice. Illustrative comments;

- *... and I did that because I wanted people to be reflective.*
- *Now some people wrote a journal and some didn't.*
- *... because every day you've got to be looking at what you're doing and taking note of things.*
- *I heard the other day about a school where the last fifteen minutes of each day were for the children to reflect on their learning for that day and then maybe we need another one after that for the teachers to reflect.*

*Modelling of exemplary practice* involves opportunities for participants to observe other professionals in action. Illustrative comments;

- *I've started to show people what I did for myself when I was planning.*

- *When you work with a partner or two or three other people they can show you what they do.*
- *The enthusiastic people were flagship people who showed others in their schools what to do.*
- *The really thoughtful ones and the more analytical ones will do a little creating of their own and show this to the others.*

*Effective use of time* implies effective management of the time available. Illustrative comments;

- *A pupil-free day makes it easier to get all the teachers together.*
- *One school has instigated afternoon workshops for purely professional development reasons.*
- *One school has a focus on calculators and they meet every two weeks.*
- *The sort of thing we were doing was very demanding and you can't sort of forget about it from one week to the other.*

*Key informants' responses: Characteristics of facilitation.* The frequency of responses given for each of the characteristics of facilitation is presented in Table 29. Illustrative comments for each of the characteristics follow the table.

Table 29
*Frequency of Key Informant Responses for Each Characteristic of Professional Development Facilitation*

| Facilitation factors | Frequency (N = 359) |
|---|---|
| Facilitator expertise | 99 |
| Resourcing | 93 |
| Environmental quality | 68 |
| Facilitative networking | 55 |
| School executive support | 44 |

*Facilitator expertise* refers to the knowledge and practical experience of personnel leading professional development activities. Illustrative comments;

- *They [curriculum project officers] have to have an understanding of the principles of professional development and effective models of professional development.*
- *We look at the sort of commitment the person has to the curriculum area, the sort of experiences they've had in the area and the delivery of workshops and information.*
- *... sometimes the people who have the skills and expertise in terms of teaching aren't necessarily people in leadership positions.*
- *The consultant we had last year was really good as he relaxed people very much and he's very reliable and he's good to work with in that he does what he says he will do.*

*Resourcing* was ranked by key informants as the second most important facilitation factor. For the purposes of this study *resourcing* has been defined as the provision of appropriate support and materials in professional development programs. Illustrative comments;

- *So we're constantly trying to pair up people coming in to inservice so that they've got that support when they go back into the school.*
- *Funding is always an issue in running [professional development] programs.*
- *I used my time to go to help people by going into their classrooms and doing what they wanted me to do.*
- *I'm convinced that if you're going to help people to make significant long-term changes, they need a lot of support.*

The opportunity to share ideas with other teachers has been referred to as *facilitative networking*. Illustrative comments;

- *... Alice Springs is setting up some sort of a mentor scheme where the preschool teachers in the urban setting take on the role of mentor for a couple of the bush schools.*
- *... networks vary tremendously but one I'm thinking of was involved in small schools, rural schools, considerable distance out of Darwin.*
- *... so one of the major other spin-offs beside school-based stuff is getting a network going.*
- *... and an issue for us [project officers] has always been, you can have a network that's fine, as long as someone's keeping it going, it has to be self-sustaining.*

The *environmental quality* of professional development activities referred to an environment which is conducive to productivity and collegiality. Illustrative comments;

- *There needs to be time to build stronger school networks, within the school.*
- *And we're not, I don't think, as teachers, supportive enough of each other.*
- *It seems to me that within schools there need to be more structures to support the teachers with professional sorts of matters.*
- *I think more people are aware that a whole group, a whole school approach, is probably the most productive.*

*Support of the school executive* was another factor related to facilitation which was identified by key informants (see Table 26).

- *... my knowledge of the hierarchy in schools would have to be that not a lot of them are sympathetic to early childhood.*

- *.. and they [school principals] play a gate-keeping role where they keep people away from teachers, protect teachers... excuse then from involvement rather than find ways to involve them.*
- *Leadership from the Principal would be a chief factor in professional development in schools.*
- *Most of the principals were very supportive and the one or two who weren't had very strong people so it didn't affect the [professional development] project.*

*Key informants' responses: Characteristics of application.* The frequency of phrases used for each of the application factors is presented in Table 30. Illustrative phrases for each of the factors follow the table.

Table 30
*Frequency of Key Informant Responses for Each Characteristic of Professional Development Application*

| Application factors | Frequency (N = 214) |
|---|---|
| Follow-up | 49 |
| Practicality | 35 |
| Sense of ownership | 32 |
| Institutionalised teamwork | 27 |
| Transferability of learning | 26 |
| Rewards | 23 |
| Demonstrated accountability | 22 |

*Follow-up* has been interpreted as professional development experiences which extend beyond a single "one-off" activity. Illustrative comments;

- *... one of the things that we have reversed... is the notion that an inservice or professional development is a one-off activity, it's a one-shot sort of thing.*

- *... what's going to take place after the pupil-free day is that over a period of months these two people [project officers] will start working closely with the teachers within their classrooms.*
- *... the quick-fix doesn't work because it doesn't linger on, it doesn't have enough hooks, doesn't make enough connections.*
- *... and that's why, often this inservice or the professional development programs, they have a full day and then you go away with a task, to try something out and come back ...*

*Practicality* refers to the extent to which the knowledge and skills gained in professional development activities can be applied in practice. Illustrative comments;

- *Some people said "Just come in to my classroom and tell me what you can see that's happening."*
- *... and the onus is on the participants to talk to other people and then they have to put something into practice.*
- *... people are asking about programming and planning because that's one of the things they're thinking about.*
- *We need to really get the emphasis back on "What do we want the children to learn?"*

A *sense of ownership* has been used to describe the empowerment which motivates teachers to continue to explore and refine their ideas and practice. Illustrative comments;

- *Some teachers prefer to work by themselves and they know what they're doing and they feel comfortable with what they're doing.*
- *And we need to be constantly evaluating our own teaching.*
- *The tutor in the schools has to identify issues and talk to other people about it.*

- *They [teachers] have to negotiate the learning model or else they don't own it, it's not their learning model.*

*Institutionalised teamwork* refers to the establishment and maintenance of respect and networking in a professional workplace. Illustrative comments;

- *Certainly, where there's a whole unit or a group of people or the whole school committed to something is where you start to see the most effective change in people's attitudes to professional development work.*
- *Because the principal wasn't interested [in a professional development program] the teachers felt let down, that there was no support.*
- *... and there has to be a commitment on the school's part—you know the organisational part of the school—to allow teachers to work together.*
- *And if you let the side down by not doing the action research and not sharing, then it's not just you that misses out ...*

*Transferability of learning* has been used to describe the application of professional development content across curriculum areas and across school sectors (for example, primary to early childhood). Illustrative comments;

- *People were making links between what they were doing in conferencing children's writing and talking to children about their mathematics.*
- *So they're starting to see how to make connections between the different curriculum areas.*
- *Teachers saw very clearly that you can meld, you don't have to have a separate program for kids with special needs because you can have a program that addresses the needs of all kids.*

- *The Integrated Curriculum Document helps teachers to see the connections between [curriculum] areas.*

*Rewards* may be in the form of academic credit, employer or colleague recognition, career advancement opportunities or other affirmations of the value of teachers' participation and achievement in professional development. Illustrative comments;

- *Some people who were involved in the project last year are now facilitators in their schools.*
- *One person who did the MaTLAP program has become a lot more involved in maths now than ever before in that she's involved in writing reviews of books and that sort of thing ...*
- *Because she [a teacher] got involved in MaTLAP she has been recruited for all sorts of other things like committees and the Maths Association.*
- *The principal actually gave the tutors in the school release time to prepare for workshops.*

*Demonstrated accountability* refers to feedback, debriefing and reporting mechanisms. Illustrative comments;

- *Further requests for professional development is one way we see if we've been successful.*
- *There are assessment and evaluation expectations upon all projects.*
- *Various evaluation forms are used in departmental inservices.*
- *Because of the federal government professional development levy there is a requirement for assessment and evaluation.*

The semi-structured interviews conducted with the four classroom teachers were analysed according to two key content areas: professional development and teaching mathematics. As with the key informant responses, the classroom teachers' professional development responses

were organised and summarised in relation to Crowther and Gaffney's (1993) characteristics of best practice in professional development. The responses related to teaching mathematics were categorised using Sullivan and Mousley's (1994) components of quality mathematics teaching. The general structure for the interview data presentation was also based on Sullivan and Mousley's work. The fidelity of interviewees' words and phrases has been preserved and the discussion follows the order in which these themes are presented in the tables which follow. The teachers' responses are based on their own experiences rather than best practice.

**Classroom Teacher Interviews: Professional Development Themes**

The frequency with which responses were coded under each professional development component is presented in Table 31. The quantitative presentation is to provide an indication of the relative importance of the various components of professional development to this group of interviewees, rather than to suggest a comparison of components.

Table 31
*Frequency of Teachers' Interviews Responses for Each Professional Development Component*

| Theme | Frequency (N = 237) |
|---|---|
| Planning | 41 |
| Implementation | 72 |
| Facilitation | 53 |
| Application | 71 |

Crowther and Gaffney (1993) identified some characteristics of best practice in relation to each professional development component. A summary table indicates the frequency of the responses given in relation to

the characteristics of each component and for each characteristic sample comments are presented in the words of interviewees.

*Teacher interviewee responses: Characteristics of planning.* The frequency of responses given for each of the characteristics of planning is presented in Table 32. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 32
*Frequency of Teacher Interviewee Responses for Each Characteristic of Professional Development Planning*

| Planning factors | Frequency (N = 41) |
|---|---|
| Participant commitment | 9 |
| Relevance | 8 |
| Choice and flexibility | 7 |
| Clarity | 5 |
| Needs-based | 4 |
| Social justice and equity | 3 |
| Preparation | 2 |
| Linkages between needs | 2 |
| Collaborative planning | 1 |

*Participant commitment* was interpreted as a requirement for teachers to be involved beyond just attending professional development activities. Illustrative comments;

- *University study is good because you're forced to do things, read things.*
- *We did EMIC last year and we went through the whole course.*

*Relevance* was interpreted as the relationship to participants' contexts and practice. Illustrative comments;

- *I don't think I'd get a lot out of doing my fourth year. at university*
- *EMIC was good because we did it in the school.*

*Flexibility* referred to the accommodation of the needs of individual teachers and *choice* of professional development experiences was interpreted as teachers being able to select experiences relevant to their personal and contextual needs. Illustrative comments;

- *This is two years in a row where I've looked through the inservice booklet and not found anything that really grabs me, suits me.*
- *At university you could choose what you want to choose, so I didn't even think of maths.*

*Clarity* referred to clear definition of goals and outcomes. Illustrative comments;

- *I did think of geometry but they told me it was transformational and I thought "Oh, what's that?" And I thought, "Well, I'll give that one a miss."*
- *If there was something really specific to early childhood I'd do it.*

The notion of *needs-based* professional development was used to refer to the identification and acknowledgement of the needs of participants. Illustrative comments;

- *Maths for me has always held an interest.*
- *I'd like to learn how children learn.*

*Social justice and equity* refers to accessibility to all teachers. Illustrative comments;

- *Well, most of us early childhood teachers, a large number are females and there is the image —females —mathematics!*
- *We were in an Aboriginal community so I had to study externally.*

*Linkages between needs* refers to the capacity of professional development to address needs at different levels such as individual, school and system. Illustrative comments;

- *Not everyone's choosing to upgrade their status by studying.*
- *If I thought mathematics was a concern I would certainly look at it.*

*Preparation* was taken to be action undertaken prior to the implementation of professional development activities. Illustrative comments;

- *Mathematics inservice does not get promoted.*
- *In the inservice book everything seems "to be advised"— there's nothing really specific.*

*Collaborative planning* was taken to mean involvement in the planning of professional development by more than one professional development stakeholder. For the purposes of this study it includes collaboration among teachers, parents, the community and other outside agencies. One illustrative comment was:

- *So I think I'd be looking at getting together with other early childhood teachers ...*

*Teacher interviewee responses: Characteristics of implementation.* Implementation was the second of the components used to categorise interviewees' comments about professional development (see Table 31). The frequency of phrases used for each of the implementation factors is presented in Table 33. The meanings attached to each of the factors and illustrative phrases follow the table.

Table 33

*Frequency of Teacher Interviewee Responses for Each Professional Development Implementation Factor*

| Implementation factors | Frequency (N = 186) |
|---|---|
| Application of adult learning theory | 31 |
| Effective use of time | 10 |
| Active engagement | 9 |
| Interactive action research | 9 |
| Balance of theory, research and practice | 8 |
| Modelling of exemplary practice | 8 |
| Balance of curriculum and pedagogy | 5 |
| Sequencing and spacing of program components | 1 |
| Reflection time | 1 |

*Application of adult learning theory* implies recognition of the expertise and experience of participants involved in professional development. Illustrative comments;

- *I found a few frustrations with going back to being a student after virtually being a research assistant for years.*
- *I've been out of teaching for twenty years, well not out of teaching, just working with adults and doing ESL.*

*Effective use of time* implies effective management of the time available. Illustrative comments;

- *I just did one subject a semester which was plenty with a young family and teaching full-time.*
- *The sessions were 7.30 in the morning when you are alert, you are fresh and you end up the session eager to go back and start in your room.*

*Active engagement* was taken to mean the inclusion of professional development experiences which actively involve participants and the participants' responses to these. Illustrative statements:

- *While I was the teacher librarian in the Aboriginal school I kept on a lot of reading and I felt I kept up really well...*
- *I am a member of the Maths Association and I go to all the inservices and I've been doing my BEd.*

*Interactive action research* refers to the potential, in professional development activities, for authentic ownership, networking and educational knowledge building. Illustrative comments;

- *In MaTLAP you do things in your own class.*
- *The other person from here [school] and I were able to come back here to school and do lots of things.*

*A balance of theory, research and practice* is taken to indicate a relationship between the skills to be developed in professional development and theoretical underpinnings. Illustrative comments;

- *When I did EMIC I said to the presenter, "Now I've got the theoretical back-up for what I've been trying to tell people I've been doing."*
- *But I think it's important to have a good theoretical basis, and I really don't regret a lot from teachers' college about the theoretical basis of what I do.*

*Modelling of exemplary practice* involves opportunities for participants to observe other professionals in action. Illustrative comments;

- *I would love to have people come in to see it when the children are still thinking because I am not teaching.*
- *I think it's good to have a chance to take what you are doing, and not only to talk about it but to show what the kids have done or said.*

*A balance of curriculum and pedagogy refers* to the linking of curriculum and teaching practices in professional development activities. Illustrative comments;

- *I could see the benefit of learning some new strategies.*
- *The planning needs to be not little pockets of number today and then measurement tomorrow.*

*Sequencing and spacing of program components* refers to the timeline for the implementation of professional development activities. Illustrative comments;

- *Personally I'd like to slow down but there are curriculum vitae which have to be built up each year.*

*Reflection time* means allowance for both structured and unstructured time for participants to reflect upon implications for their professional practice. Illustrative statements:

- *Sometimes I'd think about what I was trying to do and I'd just think "No, it's too hard, throw it away ..."*

*Teacher interviewee responses: Characteristics of facilitation.* The frequency of responses given for each of the characteristics of facilitation is presented in Table 34. The meanings attached to each of the characteristics, along with illustrative comments, follow the table.

Table 34

*Frequency of Teacher Interviewee Responses for Each Characteristic of Professional Development Facilitation*

| Facilitation factors | Frequency (N = 53) |
|---|---|
| Facilitative networking | 35 |
| Facilitator expertise | 5 |
| Resourcing | 5 |
| Environmental quality | 4 |
| School executive support | 4 |

The opportunity to share ideas with other teachers during, and following, professional development activities has been referred to as *facilitative networking*. Illustrative comments;

- *... and it's amazing what you learn from a colleague who's done something ...*
- *I think it's important that we [teachers] broaden our outlook a little bit more and find colleagues that we have things in common with.*

*Facilitator expertise* referred to the knowledge and practical experience of personnel leading professional development activities. Illustrative comments;

- *I want to work with people I respect, people I know are good and successful teachers or who have something to offer me.*
- *You've got to attend inservice courses yourself in order to know how people present.*

*Resourcing* has been defined as the provision of appropriate support and materials. Illustrative comments;

- *The journals and other things are in the library but no-one ever uses them.*
- *When I wanted the school to have two copies of the Mathematics Statement it was "No, we already have one in the library —no more."*

The *environmental quality* of professional development activities refers to an environment which is conducive to productivity and collegiality. Illustrative comments;

- *Your staff colleagues, they sort of "Oh, shame job" or you know, they ridicule you.*
- *H. often gives us really good ideas and we often have maths things and talk about maths at staff meetings.*

*Support of the school executive.*

- *I am sure my principal wouldn't mind people coming to see me teach.*
- *My principal probably wouldn't mind me going to look at other classes.*

*Teacher interviewee responses: Characteristics of application.* The frequency of responses given for each of the characteristics of application is presented in Table 35. The meanings attached to each of the characteristics in Table 35, along with illustrative comments, follow the table.

Table 35
*Frequency of Teacher Interviewee Responses for Each Characteristic of Professional Development Application*

| Application factors | Frequency (N = 71) |
|---|---|
| Follow-up | 27 |
| Transferability of learning | 13 |
| Institutionalised teamwork | 12 |
| Sense of ownership | 6 |
| Rewards | 6 |
| Practicality | 5 |
| Demonstrated accountability | 2 |

*Follow-up* has been interpreted as professional development experiences which extend beyond a single "one-off" activity. Illustrative comments;

- *After the conference I wrote down all the ideas we shared just because it interested me, I guess, following that up.*
- *Since I did MaTLAP I have put a lot of time into my maths because I go to lots of books and I get the journals.*

*Transferability of learning* has been used to describe the application of professional development content across curriculum areas and across school sectors (for example, primary to early childhood). Illustrative comments;

- *I found the language conference helpful because some of the language stuff is the same for maths.*
- *I don't usually follow them [activities]to the dot but they can be changed a little bit for the group I have.*

*Institutionalised teamwork* refers to the establishment and maintenance of respect and networking in a professional workplace. Illustrative comments;

- *We are encouraged at our school that if we've been to an inservice to share it*
- *I was team teaching and I used to come along to all of the things that another team was doing and they taught the things they'd learnt at EMIC.*

A *sense of ownership* has been used to describe the empowerment which motivates teachers to continue to explore and refine their ideas and practice. Illustrative comments;

- *I wrote up all the conference stuff and gave it to the other staff.*
- *It's been hard work but it's given me a new perspective and I can see it's much more ideal than the old way.*

*Rewards* may be in the form of academic credit, employer or colleague recognition, career advancement opportunities or other affirmations of the value of teachers' participation and achievement. Illustrative comments;

- *It's [the approach to teaching mathematics] not very different to what I did thirty years ago, it's just got a different name but I was really glad that I did the course.*
- *This year I'm the Mathematics Curriculum Coordinator at the school.*

*Practicality* refers to the extent to which the knowledge and skills gained in professional development activities can be applied in practice. Illustrative statements:

- *It was very different to the maths I'd been teaching in my class.*

- *I did find a lot of things really good about the course, very useful.*

*Demonstrated accountability* refers to feedback, debriefing and reporting mechanisms. One illustrative comment was:

- *I took a lot of ideas back to the school.*

### Classroom Teacher Interviews: Mathematics Teaching

Sullivan and Mousley (1994) identified six components, each with subcategories, of quality mathematics teaching. These have been used for the classification of data related to mathematics teaching from the teacher interviews. Table 36 shows the distribution of responses in the various categories.

Table 36
*Teacher Interviewee Responses to Mathematics Teaching According to Key Components.*

| Component | Frequency (N = 544) |
|---|---|
| Building understanding | 165 |
| Communicating | 36 |
| Engaging | 82 |
| Problem solving | 57 |
| Nurturing | 90 |
| Organising for learning | 114 |

The term *building understanding* was used to refer to statements which indicated that the teacher had played a role in assisting children to develop particular mathematical understandings. Table 37 shows the frequency of responses related to the subcategories within this key component.

Table 37

*Frequency of Teacher Interviewee Responses in Each Subcategory of Building Understanding*

| Subcategory | Frequency (N = 165) |
|---|---|
| Materials | 43 |
| Conceptual understanding | 37 |
| Mathematical thinking | 35 |
| Connections | 19 |
| Sequence | 16 |
| Reflection | 6 |
| Review | 5 |
| Prior knowledge | 4 |

The subcategory of *materials* was used to describe responses which included reference to concrete materials and representations, teaching aids and materials and equipment which assists in demonstration or student use. Illustrative comments;

- *I use a book on fractions that has games in it.*
- *Money I find really difficult to teach because we don't have a lot of money to use.*
- *I used to work out of a textbook but H. said, "No, throw away the maths book."*
- *I often found, using concrete materials, it was a mess or we had it spilt or someone tipped the whole box over.*

Statements coded as *conceptual understanding* related to actions by teachers or students which helped children develop mathematical concepts or procedures. Illustrative comments;

- *We made a Rice Bubbles packet and they [the children] told me it was a rectangular prism, and how many sides and edges and faces and all the rest of it.*

- *One girl said, "I built my towers in four." and when I asked her what she found out she said, "Six fours are twenty four."*
- *If I ask how many fifty cents in five dollars they [the children] can do that but I just found that they couldn't make up eight five cents in coins."*
- *We do lots of activities and I want to get from these activities various concepts.*

*Mathematical thinking* was interpreted as the provision of opportunities for children to express their mathematical ideas. Illustrative comments;

- *The children had the LEGO and started counting and there was a lot of spontaneous language.*
- *I get concerned when I see other people teach to the curriculum and forget to teach the children.*
- *I let the girl draw a picture and tell me what she'd worked out.*
- *During the story he worked out that if the duck goes with the fish there would be a pair.*

Statements coded as *connections* were those which indicated that teachers were aware of children's attempts to establish mathematical connections and relationships. Illustrative comments;

- *I'm trying to have children see the sense of what we are doing in a whole lot of areas.*
- *I might say that it's actually maths groups but the children might be working on art and craft or on an area where they are discovering mapping ...*
- *I guess it's allowing opportunity for them [the children]to see the relationship between things that we've arbitrarily sort of chopped up into separate bits. ..*

- *At preschool level they [teachers] don't have maths as one section that they're learning and then reading as another part, they just mix it all up together.*

*Sequence* was used to categorise statements which indicated a teaching plan involving developmental steps. Illustrative comments;

- *The planning is largely sequential and there's things that fit in that provide the content for covering the steps along the pathway.*
- *They [the children] like to have things that are interesting but they still have to have some sort of sequence.*
- *I wasn't sure how to teach some things and someone [a colleague]would say to me, "That's not what you do next."*
- *I try to get the children to see what's coming next so they draw groups which leads to repetitive addition then later to multiplication.*

Statements which indicated that teachers had observed, or provided for, children reflecting upon their activity were coded as *reflection.* Illustrative comments;

- *At the end of the lesson to have them all sit and recap on all those activities is a lot of time so I do a group at a time.*
- *I asked the children to think about what they'd done and how we could use the play money we had been given.*
- *W. [child]had been thinking about the groupings in the story and remembered them later.*
- *At the end of the activity time we talk about what we've done.*

*Review* was used to classify statements which related to summarising content or obtaining feedback from children. Illustrative comments;

- *Doing a recap of the lesson is something I probably should think about at times.*

- *Even though you have a lot of things going on at the one time you've still got to tie them up.*

Statements which mentioned links to the children's previous experiences were coded as *prior knowledge.* Illustrative comments;

- *Sometimes when I receive children from other teachers it is a concern for me when these other children come and they have no thinking abilities.*
- *One of my strengths is really picking up from where the children are at.*

The term *communicating* was used to refer to statements which related to opportunities for talking, explaining, describing, listening, asking, clarifying sharing, writing, reporting and recording. Table 38 shows the frequency of responses related to the subcategories within this key component.

Table 38
*Frequency of Teacher Interviewee Responses in Each Subcategory of Communicating*

| Subcategory | Frequency (N = 36) |
|---|---|
| Discussion between pupils | 10 |
| Cooperative situations | 10 |
| Sharing strategies | 9 |
| Recording | 7 |

*Discussion between pupils* was used to categorise responses which referred to both planned and unplanned verbal interactions between pupils. Illustrative comments;

- *When you do group work you have to leave enough time at the end to share what the children have done—in that group and in the whole class.*
- *It's good to get the children to recap at the end.*

*Cooperative situations* was taken to refer to opportunities for interactions and shared learning. Illustrative comments;

- *The children like to work together in groups.*
- *The groups are hard work but there's more involvement.*

*Sharing strategies.* Illustrative comments;

- *In groups there's more helping and sharing..*
- *I try to let them have time to talk about what they've done in their groups*

*Recording.* Illustrative comments;

- *I do a lot of work where they're [the children] using different kinds of recording.*
- *Sometimes the recording is just on bits of paper and cardboard.*

The term *engaging* was used to refer to statements which indicated that students were involved in their own learning. Table 39 shows the frequency of responses related to the subcategories within this key component.

Table 39
*Frequency of Teacher Interviewee Responses in Each Subcategory of Engaging*

| Subcategory | Frequency (N = 82) |
|---|---|
| Active involvement | 25 |
| Variety | 19 |
| Personally relevant | 12 |
| Motivation | 10 |
| Enjoyment | 8 |
| Real world | 8 |

*Active involvement* was used to code responses which referred to physical activity. Illustrative comments;

- *A lot of learning comes out of play activities.*
- *When we go to the library we count people and line up in pairs.*

*Variety* referred to provision of a variety of equipment, choice of tasks and the use of a variety of approaches. Illustrative comments;

- *Sometimes I link the maths to literature...*
- *I like a lot of variety and a lot of concrete work.*

*Personally relevant* was interpreted as having meaning and being relevant to children. Illustrative comments;

- *We got some play money and the children asked if they could play shops.*
- *They [the children] should all be learning from the blackboard but I don't think they do.*

*Motivation* refers to a rationale for encouraging students to become engaged in their learning or, in other words, to want to learn. Illustrative comments;

- *I've found you just start reading stories about animals and the children get really interested and just take off with counting and grouping and construction ...*
- *... and to me motivation in mathematics is not just to know two plus two and minus and times tables.*

*Enjoyment.* Illustrative comments;

- *The children don't like dull, boring things all the time, they like to have things that are interesting ...*
- *They [the children] were very excited about learning how to draw the 3D shapes.*

*Real world* was used to code responses which related to familiar experiences of children or opportunities to apply skills and understandings. Illustrative comments;

- *When we want to count we go out and count suitcases or bags, or we count cars in the carpark, that sort of thing.*
- *The things they [the children] have at home they know how to use at school.*

The term *problem solving* was used to refer to statements which indicated that the teacher had played a role in assisting children to develop particular mathematical understandings. Table 40 shows the frequency of responses related to the subcategories within this key component.

Table 40
*Frequency of Teacher Interviewee Responses in Each Subcategory of Problem Solving*

| Subcategory | Frequency (N = 57) |
|---|---|
| Investigation/problem solving | 20 |
| Challenging | 16 |
| Open-ended activities | 11 |
| Problem posing | 10 |

*Investigation/problem solving* was interpreted as student involvement in solving problems and investigations. Illustrative comments;

- *If you develop problem solving and then they [the children] are ready for whatever kind of curriculum you have to teach.*
- *Mathematics to me is solving problems and not just mathematical problems.*

*Challenging* was interpreted as extending children's thinking. Illustrative comments;

- *I provoke, I challenge the kids with lots of concrete stuff.*

- *I tried to get the children to see how far they could go with making the boxes and drawing them.*

*Open-ended activities* were those which encouraged creative thinking. Illustrative comments;

- *I get the children to work by themselves with activity cards which really get them to think.*
- *I gave them [the children] all these boxes and said "Now what could you do with that?"*

*Problem posing* was interpreted as the children being able to articulate problems for themselves after interaction with materials or real-world situations. Illustrative comments;

- *I said to the children; "What sort of questions would you like answered about this?"*
- *The children made lots of suggestions about what they needed to find out and who they would ask.*

The term *nurturing* was used to refer to statements which indicated that the teacher had played a role in assisting children to develop particular mathematical understandings. Table 41 shows the frequency of responses related to the subcategories within this key component.

Table 41
*Frequency of Teacher Interviewee Responses in Each Subcategory of Nurturing*

| Subcategory | Frequency (N = 90) |
|---|---|
| Catering for levels of ability | 47 |
| Enthusiasm | 16 |
| Non-threatening | 12 |
| Relationships | 6 |
| Rapport | 5 |
| Goal setting | 4 |

Responses relating to catering for individual differences were coded as *catering for levels of ability.* Illustrative comments;

- *I have to be very careful that I keep track of where all my students are at an individual level.*
- *So then I have to make sure that the children who aren't very confident get to think about how to do it [a maths activity] and that I'm there to check how they're going.*

*Enthusiasm* relates to a positive attitude by the teacher. Illustrative comments;

- *When I've been to inservices I'm really keen to try things out in the classroom.*
- *So when I motivate the children and when I see their response, that is beautiful.*

*Non-threatening* relates to a positive and encouraging classroom environment. Illustrative comments;

- *The children decided to use straws and got their groups of five together on the floor and did it all by themselves.*
- *The children pick up if you say something incorrect mathematically and you make it out as a fun thing as though you're a real dummy and they're the smartest lot out.*

Responses which related to the nature of the interactions between the teacher and children were referred to as *relationships.* Illustrative comments;

- *There's usually someone who's good at maths or a few who are reasonably good at maths and a couple in the group that aren't so I get them to help each other.*

*Rapport.* Illustrative comments;

- *I tell the kids when they're starting to muck up with the materials and they know to use them properly.*

*Goal setting.* Illustrative comment;

- *I was watching one or two of the girls who're very quick and we said we'd have to move on to some more difficult games.*

The term *organising for learning* was used to refer to statements which indicated that Table 42 shows the frequency of responses related to the subcategories within this key component.

Table 42
*Frequency of Teacher Interviewee Responses in Each Subcategory of Organising for Learning*

| Subcategory | Frequency (N = 114) |
|---|---|
| Organisation | 43 |
| Assessment | 30 |
| Clear instruction | 19 |
| Clear purpose | 12 |
| Questions | 10 |

*Organisation.* Illustrative phrases:

- *I plan ahead for ten weeks and then work out how to spread topics over particular days.*
- *Having groups can be very messy and you waste your time packing up.*

*Assessment.* Illustrative comments;

- *You're in a position to see what the children are doing when they work in groups and you're with a kind of monitoring group.*
- *Sometimes I get to the end of the year and, oh, it's report time and so I find a new game to help me with assessment.*

When the teacher indicated a selection of direction for a lesson or a series of experiences this was coded as clear *instruction.* Illustrative comments;

- *I try to take something that I'm doing and mesh it into other things, other curriculum areas.*
- *I see young teachers who do a bit of this, a bit of that, like they don't know where they're going.*

*Clear purpose.* Illustrative comments;

- *I have the curriculum in one part of my mind and then in the other part of my mind are the kind of things I want to cover.*
- *I tried to justify to the parents why I didn't want to just teach the children add-ups, that I wanted to do other things.*

*Questions.* Illustrative comments:

- *You can make suggestions to children who felt frustrated like, "Have you thought of this?"*
- *One child showed me a tower and I said, "Oh yes, and what did you find out?"*

## Summary

The data summarised in this chapter were drawn from interviews with key informants and four classroom teachers who had completed the questionnaire described in the previous two chapters. The interview data, although derived from open-ended interview questions, were suitable for analysis using frameworks developed by other researchers. The interview data supplement data drawn from documents and from the questionnaire.

The extent to which the results of this study confirm or challenge other relevant research is the subject of the following chapter. The results will be discussed in relation to existing knowledge of best practice in professional development, early childhood education and mathematics education. An outcome of the discussion will be the identification of implications for

future provision of professional development in early childhood mathematics education.

# CHAPTER 7

# DISCUSSION

## Introduction

A predominant theme emerging from the discussion in previous chapters is the individual teacher's construction of an approach to teaching mathematics to young children. In Chapters 2 and 3, the Literature Review, the role of professional development in this construction was considered. It was suggested that if appropriate professional development is available and if the change process is successfully managed, then teachers are more likely to adopt practices which contribute to effective mathematics learning in young children. Data presented in the previous two chapters suggested that, although professional development activities may have had positive outcomes for participants, many teachers still had concerns about particular aspects of their mathematics teaching. If teachers' comments about their work with children and their professional development experiences are closely examined and acted upon by professional development planners and providers, then the design and implementation of appropriate support structures and networks might be facilitated.

In this chapter significant aspects of the results presented in the previous two chapters are analysed in order to enhance further discussion on the ways in which early childhood teachers develop a mathematics teaching persona. The words of the teachers have been used to illustrate individual attitudes and responses to learning about, and teaching, early childhood mathematics. The anecdotal evidence presented in this chapter provides further crucial insights into the contexts in which teachers operate and highlights the importance of recognising and catering for the individual needs of adult learners.

In order to form recommendations related to improved professional development provision for early childhood teachers it is necessary to address some of the significant professional issues which have been identified in this study. In the first part of this chapter the focus is on teacher backgrounds and how aspects of these backgrounds influence both professional development and mathematics teaching. The extent to which these influences can be extended, modified, or perhaps even eliminated, may assist individual teachers, and professionals, engaged in overseeing or supporting their work, to articulate and attain goals consistent with exemplary practice. Acknowledging the backgrounds of participants should enable professional development planners and providers to identify needs in appropriate ways. Discussion in this chapter, supported by data from this study, reveals the complexity of this identification process. Consideration of work contexts, processes, content and delivery modes were mentioned by teachers and key informants as essential elements in relation to identifying professional development needs. Another essential element, according to participants in this study, is the inclusion of various forms of collegial activity in professional development experiences. The support of colleagues was viewed as crucial but, from the perspectives of the teachers, needs to be accompanied by other forms of formal and informal support for the change process.

Underpinning the discussion of professional development in this chapter is the particular content focus in relation to this study, namely, teaching mathematics. The mathematics teaching and learning issues which emerged as of interest and concern to the teachers involved in the study include understanding how children learn mathematics, the use of resources, and planning. The elaboration of these issues highlights an apparent tension between espousing ideal practice and implementing appropriate practices. Teachers' revelations of what they actually do are

contrasted with what they know about successful mathematics teaching and some conclusions will be drawn in relation to the degree of correlation.

The discontinuity between rhetoric and practice is the subject of the final section of this discussion chapter in which the change process is revisited. An outline of some perceived obstacles to change is presented along with some suggestions for greater facilitation of change. Finally, the major themes of the chapter are intertwined to emphasise the complexity of the whole teacher professional development issue.

*Professional Development Research*

The review of literature related to professional development (Chapter 2) enabled the identification of factors which, in the past, had diminished the effectiveness of teacher professional development. The use of a "deficit model" of organisation and a view of teaching as craft contributed to a dominant conformist paradigm frequently translated into prescriptive, centrist programs which ignored the needs of teachers as self-directed, adult learners. Further, many professional development planners paid little attention to the concerns, interests and contexts of individual teachers and failed to involve them in the planning of professional development programs.

Increased interest in professional development in the 1980s led to significant changes in its organisation. Recent views of professional development have incorporated the notion of lifelong learning and accommodation of diverse teacher needs and responsibilities. Inherent in a reconceptualised view of teacher professional development is the necessity to consider adult learning theory in the planning and implementation of programs. Such consideration includes a focus on the contexts in which individual teachers work and greater attention to the support mechanisms which might assist in ensuring long-term change. Understanding and

managing change are additional dimensions of the contemporary professional development arena which have assumed increased importance. In summary, there is significant evidence to suggest that educators are aware of the factors which contribute to successful professional development yet the experiences of the teachers in this study would indicate that the rhetoric is not always a reality.

## Teacher Backgrounds and Professional Development

*Experience*

The professional behaviour of a teacher is not only determined by a present organisational context but also by a life history and related experiences (Ball, 1996; Kelchtermans & Vandenberghe, 1994; Wadlington, 1995). The background data presented in Chapter 5 of this study show that participants were teachers of significant professional experience. Questionnaire responses and data from the teacher interviews indicated that there were three significant aspects of the teachers' age and experience which might warrant attention in relation to the organisation of professional development: (a) the extent, diversity and perceived relevance of the teachers' experience; (b) their perceptions of its value; and (c) the relationship between experience and professional development.

*Teachers' experience.* Some teachers considered that experiences other than teaching in schools contributed to their professional growth. The following statements illustrate this claim.

- *In 1977 I returned to teaching after 13 years and went to an inservice in Alice Springs with Victorian guest Marj Hookey. I was introduced to "Mathematics Their Way" by Mary Baratta Lorton. It fitted in with my own ideas after bringing up four children from babyhood to school age.*

- *I came back to teaching after being away from full-time teaching for nearly twenty years. I taught for six years after I was trained then my husband and I trained as linguists and I taught adults in an Aboriginal community. I was also a teacher librarian and, of course, I watched my own kids learn to read.*
- *I went back to do a BEd because I'd been out of teaching, well, doing ESL with adults.*
- *My previous experience and experimentation gave me a good basis for the unit.*

Some teachers explained that even when not employed teaching children they had "kept up" with what was happening in schools through reading or through being involved in their own children's school experiences.

*Perceived value of experience.* Experienced teachers viewed their experience in different ways. To some teachers all experience contributed to professional growth, as this teacher reported:

- *Doing inservice gave me answers to fill in the gaps because I'd been trying to fill them in, but just not having the answers. Because, I mean, there's huge gaps from when I trained thirty years ago to now.*

Other teachers found that their experience was not acknowledged in professional development activities or in formal award study.

- *The inservice presenter didn't know where we were at so while she knew her stuff, it was too general.*
- *I found a few frustrations going back to being a student after virtually being a research assistant. I found it difficult to say what the lecturers told me to say. You know, like you got two ticks if you quoted them. I found it very difficult to go back to being a little monkey.*

The sentiments of the teachers quoted are supported by the work of Hyde (1989) and Wadlington (1995) who claimed that, although most staff development programs for veteran teachers are concerned with helping them improve, develop, change or learn, well-articulated theories of adult learning and development are scarce.

*Experience and professional development.* Howse (1991) contended that the educational, personal and personnel implications of increased numbers of teachers with more than twenty years of experience require further study. He went on to comment that insufficient attention has been given to the growing, recurrent needs of an ageing teaching force. This view is supported by DEET (1988) in statements which suggest that the provision of professional development is complicated by a need to assist ageing teachers to assimilate new skills, knowledge and attitudes very quickly. Older, experienced teachers often acknowledge the difficulties they experience in changing established approaches to teaching. These difficulties were exemplified in the comments of a female teacher, in the 51 to 60 age bracket, of more than twenty-years' teaching experience.

- *All the staff were working on maths and sometimes I'd just think, "No, it's too hard, throw it away."*
- *H. has been really encouraging. She shows me things and gives me materials.*
- *It's not that the ideas aren't there. It's just that sometimes I thought, "Ah, too much stress, go back to the old way."*

This anecdotal evidence supports the view that even experienced teachers need support to assist them with their organisation for mathematics teaching. For some experienced teachers, however, involvement in professional development may be hindered by the attitudes of senior school staff. An education officer interviewed in this study reported how this occurred.

> *... they [principals, assistant principals] play a gatekeeping role where they keep people away from teachers, protect teachers, you know, "Well, that person's experienced, has been around a long while, there's nothing you can tell them." Or "Oh no, you don't get any of them, they're too prickly."*

Reflection on the situation described above leads the reader to consider the complexity of professional development and education change. Do poor professional development experiences contribute to a loss of confidence in the change process and a reluctance to participate? Or does the failure to acknowledge individuals' experiences and attitudes create a fear that participants may be required to change too much, too quickly? Beers (1993) asserted that, in the training of experienced teachers, it is important to assume that they know what they are doing and will grow through support in articulating what they do.

Hyde (1989) suggested some guidelines for professional development programs for experienced teachers. An essential element, according to Hyde, is exposure to role-taking experiences in which teachers must employ new models, not merely hear about, observe or experience them vicariously. Role-taking experiences must be appropriate to the teachers' levels of development and should be accompanied by careful and continuous guided reflection. Hyde contended that experience and reflection should be continuous processes, probably occurring over one year. Many of the professional development programs mentioned by participants in this study included most of Hyde's suggestions. Successful long-term change does, however, rely on teachers' capacities for reflection and application, and on the extent of ongoing support that they receive. The issues of reflection and support are addressed in greater detail later in this chapter.

*Critical Incidents*

In addition to age and experience there are other factors associated with teachers' backgrounds which influence their current professional practice. Two of these are critical incidents and critical persons. Kelchtermans and Vandenberghe (1994) described critical incidents as key events around which pivotal decisions revolve. Goodson (1991) claimed that such incidents may crucially affect perception and practice and are often mentioned by teachers as important in their professional histories. He contended that critical incidents are events which challenge the professional self of the teacher. Kelchtermans and Vandenberghe (1994) concluded that critical incidents were interesting as they are often linked to changes in professional behaviour. They used the following two criteria for the definition of an event, person or phase as "critical":

- The respondent refers to the event as very meaningful. The fact that the respondent retrieves the situation from his or her memory and presents it as a meaningful event is a clear indication of importance;
- The meaningfulness of the incident is linked to the professional self, subjective education theory or professional behaviour. This becomes clear in concrete descriptions and interpretations of such events. (p. 32)

Teachers remember incidents which taught them something about children or teachers. In this study teacher respondents offered, without explicit requests, a number of examples of critical incidents. Three of these are presented below.

- *I had a child who didn't know the value of 10 cents. I asked what she could buy. She said she could buy an icecream. I said she didn't have enough money. I gave her a real 10 cents and sent her to the tuckshop thinking I could demonstrate a "real" situation. She came back with an ice cream. The tuckshop lady had felt sorry for her!*

- *I saw the children playing cards at recess. They were gambling. I then realised why some of their money concepts and quick mental arithmetic far outweighed other important areas in the curriculum.*
- *Recently a child in my class described how the stick he was using for a model of a pterydactyl was the same length as his friend's. It was his own observation and action to confirm his estimation which impressed me and made me confirm my belief that maths lessons never stop and young children are constantly learning.*

Descriptions of critical incidents were found in the teacher responses to most of the questions included in the questionnaire. Kelchtermans and Vandenberghe (1994) claimed that narrating critical incidents may encourage reflection on the teaching process. McLean (1993) suggested that studying teachers' stories helped integrate the teaching process and preserve the "whole" rather than fragment it into discrete skills or competencies. Inclusion, in professional development experiences, of opportunities to reflect upon critical incidents is one way of helping teachers to link their backgrounds, experiences and knowledge and their professional concerns and interests. Recognition of the professional development significance of critical incidents is evident in their explicit inclusion and exploration in recent professional texts (see, for example, Patterson et al, 1995; Wien, 1995).

*Critical Persons*

Research by Kelchtermans and Vandenberghe (1994) led them to a discussion of critical persons, that is, specific individuals who were mentioned by teachers as having had an important impact on their professional biographies. Critical persons were individuals whose presence and behaviour strongly influenced the professional self and the subjective

education theory of the respondent (Kelchtermans & Vandenberghe, 1994). The following excerpts from the questionnaire responses of this study illustrate the profound and lasting influence of critical persons.

- *In 1978 or 1979 (I was still an undergraduate at this stage) I attended a two day workshop with Marj Hookey from the Victorian Education Department. The workshop influenced my interest in maths teaching because she showed us many interesting activities.*
- *In 1977 I returned to teaching after 13 years and went to an inservice in Alice Springs with Victorian guest Marj Hookey. I was introduced to "Mathematics Their Way" by Mary Baratta Lorton. It fitted in with my own ideas after bringing up four children from babyhood to school age.*
- *In 1981 Beth Graham ran an inservice at Strelley schools and showed us how to share our mathematical thinking with Aboriginal kids. It had impact because Beth was respected—she knew about teaching in this context—not like an office John or academic.*

These examples demonstrate the long-term impact that significant individuals may have on the professional life of a teacher, and indicate that perhaps there is a need for greater recognition of this aspect of teachers' professional growth in relation to the formal and informal selection of workshop leaders, mentors and teaching partners.

*Teaching Contexts*

The professional development literature of the past two decades has stressed the need for professional development activities to be linked to the contexts of participants (see, for example, Boomer, 1987; Lovitt et al., 1990). Recognition of the extreme diversity of contexts in which Australian

teachers work should, according to Crowther and Gaffney (1993), be a priority for projects initiated under the recent National Professional Development Program. Their recommendation is valid in the light of the comments of some of the teachers in this study. Teachers of Aboriginal children and teachers in isolated schools commented that their professional development needs were not met. In response to being asked to nominate a professional development activity which was personally unsuccessful one respondent commented:

> *Standardised tests in rural schools—this needs to be reviewed very carefully—a lot more looking at the curriculum in Aboriginal schools.*

In response to a question which asked respondents to state what provided the motivation for involvement in professional development activities one respondent replied:

> *Nothing—inservices don't seem to be relevant to early childhood Aboriginal schools.*

A question asking teachers to nominate professional development experiences appropriate for their current needs yielded, among others, the following responses:

- *I would like something on Aboriginal teaching of maths.*
- *Developing resources for Aboriginal children and working with Aboriginal assistant teachers to work out objectives, learning outcomes, etc.*
- *I would like to do subjects on critical maths education.*

Jalongo (1991) reported that, when asked to identify sources of professional dissatisfaction two of the categories of complaints identified by teachers were lack of support for instructional problems, such as inadequate teaching materials, and inadequate preparation and support when dealing with

special populations of children. This is evident in teachers' comments in relation to working with Aboriginal children.

- *I feel that the language barrier slows mathematical learning for Aboriginal children considerably. I teach new concepts to small groups. I enlist the help of my Aboriginal teacher assistant to teach new concepts to children sometimes.*
- *Mathematics teaching in a rural Aboriginal school is slow, heavy going because of the necessary language involved.*
- *At many times like I'm wasting my time and efforts due to children, in my view, not being ready for formal school, let alone formal maths.*
- *I teach Aboriginal children who are not aware of, or familiar with, a lot of the concepts we assume all children are aware of. I try to make my maths culturally relevant.*
- *I lack the confidence and knowledge on how to move kids on, especially Aboriginal kids with very little English.*
- *In a cross-cultural setting I believe mathematics is easier to teach than language.*
- *When children have limited concepts of space, colour, etc, some "maths" experiences are lost in the general presentation.*

A number of writers (see, for example, Collins, 1992; Higgins, 1991; Jones, Kershaw & Sparrow, 1995; Roberts, 1992) have identified factors which they felt contributed to the difficulties of teaching Aboriginal children. The most frequently mentioned factors are language and cultural variables. Other factors include health problems (for example, hearing loss), perceptions of self as poor learners, regard for the teacher (person orientation), cognitive styles, learning differences, socio-economic circumstances, illiterate parents, teacher expectations and low attendance rates. Jones, Kershaw and Sparrow (1995) stated that education programs which were premised on particular

parenting styles and preschool experiences assume that a range of educationally relevant processes have been established prior to the commencement of formal schooling. The experiences which assist non-Aboriginal children prepare for school are not commonly featured in traditional informal Aboriginal education. Higgins (1991) contended that the majority of teachers who come to Aboriginal schools are young and that their pedagogical training is based on the needs of the mainstream "Westernised" student. He concluded that such teachers are, therefore, ill-prepared for work with Aboriginal children. The types of culturally sensitive programs described by Jones, Kershaw and Sparrow (1995) are not yet widespread and consideration of their underlying principles and practices has only recently become a feature of preservice and inservice programs.

Teachers working with Aboriginal children are often aware that their teaching approaches are inappropriate. When asked to provide examples of incidents when children were not learning mathematics one teacher wrote:

> *Aboriginal children doing "sums"—pages of 44 + 22 =, etc*

Another described the following incident.

> *When asked to take part in an activity involving counting-on strategies with some expensive and attractive workcards the children made hats with the fold-up cards. I suppose I could say they were experimenting with area and shape but there was not a significant amount of counting going on!*

Teachers of Aboriginal children are often discouraged by what they perceive as an apparent lack of learning. Parents may also be disappointed. Roberts (1992) claimed that some Aboriginal parents believe that just by attending school their children will learn. A major cultural difference is that in Aboriginal society children learn by watching and listening whereas in

Western learning there is an expectation that students will construct meaning through their interaction with materials and people.

Even if cultural differences were acknowledged, planning and programming would still present a challenge for teachers of Aboriginal children. Teachers described a range of approaches that they used in an attempt to meet the needs of Aboriginal students, including the following points:

- *Try to follow the WA syllabus but mainly base my teaching activities on where the children are at and what they will need to know to function independently in their community.*
- *All in context. Classroom routines as maths eg calling the roll, calendar, absent/present; bar graphs of attendance, how many scissors do we need to ... ? The problem-solving sessions arise from curious questions in class.*
- *I use the resource Teaching Aboriginal Children Mathematics (NT Department of Education).*

As mentioned earlier the social context of mathematics education has not been effectively tackled in the past because of the broad range of factors which need to be considered (Harris, 1991). These issues range from the nature of mathematics itself through to the influence of the institutional setting of the school, to parental and societal expectations and pressures, to sex-role stereotyping, and finally to linguistic considerations of the relationships between culture, language and learning.

Teachers in isolated schools, most of which had Aboriginal students, also described difficulties in meeting their professional development needs.

- *In small schools it is the opportunity, not the funding, that stops me.*
- *I need something appropriate for small schools—organisation, games.*

- *Relief teacher unavailability and child care costs while in Darwin make inservices impossible to attend.*

At the time that this study was undertaken, attempts were being made to redress some of the problems of professional development provision for teachers in isolated schools. A principal education officer described how the needs of teachers in rural schools were identified and met.

> *After discussion with a project officer there may be some relief days offered for teachers to go across to other schools. Instead of travelling to Darwin they might meet at a hot point within a particular district. The teachers meet and the project officer supports them by distributing information and resources.*

Beers (1993) suggested that teachers in isolated settings need training which supports their continuing reflection on practice and autonomous decision making. This view is supported by DEET (1991a) in statements which suggested that teachers in special circumstances, especially those in remote areas, require a substantial proportion of state and territory professional development budgets.

### Identifying and Planning for Professional Development Needs

Effective professional development planning includes recognition of teachers' perceptions of their requirements. Eraut (1993) claimed that teachers' needs may relate to an improvement of their practice or to redirection of their goals. He further claimed that their needs may be identified either by teachers themselves or by others within or outside the school. Eraut warned, however, that it cannot be assumed that merely identifying teachers' needs is the first stage in planning a program of professional development. He claimed that engaging in needs assessment is itself a form of teachers' development and that needs assessment and

teacher development are symbiotic processes. The relationship between needs and teacher professional development may have been neglected in the past because of "top down" approaches to teacher professional development (see Chapter 2) but has been recognised in many contemporary programs.

Data collected in this research project revealed that teachers and others involved in professional development provision have clear ideas about what constitutes successful professional development (see Tables 13, 23 and 24). Statements made about preferred experiences, contexts and processes provide support for the fact that change has occurred but indicate that there is more work to be done to ensure that all teachers have access to exemplary professional development experiences.

*Professional Development Options*

Teachers in this study mentioned a range of professional development options which they had experienced or thought would be appropriate for them (see Chapter 5). The options which teachers described are compared with the suggestions of several writers (Clemson & Clemson, 1994; Craft, 1996; Dean, 1991; Jones et al., 1993; Katz, 1977) in Table 43.

It is apparent that the full repertoire of professional development options has not been available to all teachers. This may be because teachers have been presented with limited choices, because they are unaware of alternative activities or because organisational factors prohibit access to some options. Teachers' knowledge of the extent of their professional development options is likely to be coloured by their views of the purposes of professional development. For some teachers professional development is a morale-enhancing activity (DEET, 1991b). For others it may be a means to update practice, to support award study, to confirm practice or to meet other teachers (Jones et al., 1993).

Table 43

*Teacher Professional Development Options.*

| Examples cited in literature | Experienced by teachers in the study |
|---|---|
| Professional association membership | Yes |
| Professional conferences/workshops | Yes |
| Subscription to professional journals | Yes |
| Award study | Yes |
| Visiting other early childhood programs | No |
| Participating actively in staff meetings | Yes |
| Inservice training sessions | Yes |
| Keeping an up-to-date curriculum activities file | No |
| Participating in research projects | No |
| Work with a colleague in one's own school | Yes |
| Work with a colleague in another school | No |
| Help from advisory teachers | Yes |
| Help from teacher educators | No |
| Engaging in personal mathematical activity | No |
| Coaching | Yes |
| Experimental work with children | No |
| Giving a talk to a group | Yes |
| Keeping a diary | No |
| Observation then discussion with other teachers | No |
| Personal reading and study | Yes |
| Preparing a report | No |
| Reflecting on one's own performance | Yes |
| Shadowing a pupil or being a pupil for one day | No |
| Using distance learning materials | Yes |
| Shadowing a senior colleague | No |
| Taking part in a group problem-solving activity | No |

It was evident that teachers had limited access to options such as visiting other programs and working with colleagues from other schools. These were, however, options which were mentioned favourably by many teachers in this study (see Tables 13 and 34). One teacher said:

*I'd like to spend time with my peers–observing their practice and discussing planning methods and also recording of information about children's mathematical understanding (how to keep track effectively!!!)*

Jalongo (1991) claimed that insufficient opportunities to interact with fellow professionals, especially colleagues, was one of the sources of professional dissatisfaction cited by teachers. Crowther and Gaffney (1993) and Price (1997) agreed that the preferred learning approach of most teachers includes a strong emphasis upon collegial dialogue, incorporating team building, school development and interactive action research. For some teachers an explicit request for quite structured peer interactions was suggested.

*I think it would be good to return to "dem" lessons so students and experienced teachers get a chance to see how other people do things. If you were giving the lesson you just say, "This is how I do it. It may or may not work for you."*

In a discussion of models of change, Hatfield and Price (1992) suggested that demonstration classes be used but that the demonstrations be followed by visits from the demonstration teachers to the classes of observers. Craft (1996) added that the key feature of any visit should be a clear focus and appropriate follow-up. An alternative to visits to other classrooms is for teachers to watch videotapes of children discussing mathematics or actively engaged with a mathematics problem. Ball (1996) stated that despite the widespread enthusiasm for this method little is known about what people attend to, and learn, while watching tapes. Consideration needs to be given to issues such as the choice of teacher (for example, novice, experienced, struggling), whether the focus should be the children or the teacher, the aspects of the curriculum being documented and the availability of additional material. Another important question posed by Ball (1996) involves the "pedagogy" of using videotapes and the organisational

structures which would ensure participants could gain maximum benefit from the viewing.

Working with fellow professionals may be a favoured form of professional development but is often accompanied by solitary activity as these comments indicate.

- *Most of my maths professional development in recent years has been through informal discussion with colleagues and reading of new publications related to maths curriculum.*
- *My professional development is doing my own reading and talking to others.*

In addition to learning from colleagues some teachers consider their professional development needs and interests can be met by contributing to the organisation and by leadership of professional development activities.

- *I would like to help other teachers develop and implement more hands-on individually-aimed programs.*
- *I'm always reading something of a professional nature and I like to share those things with other staff, get them thinking.*
- *I would love to have people come in to see it when the children are thinking, to see what they do.*

Although several teachers expressed an interest in assisting other teachers they were aware of some of the skills and abilities needed.

- *... that's another area of development, that learning to share level.*
- *It takes an awful lot of courage and an awful lot of change of attitude or methods of presentation to get up in front of a group of people.*
- *I want more facilitation of workshops so that my own people management skills could be enhanced <u>AND</u> more people*

*would have the opportunity to share their ideas/activities/resources.* (original emphasis)

If teachers are to work with their peers then it is essential to assist them to acquire the necessary skills. The implication is that professional development options should include opportunities to learn about working with adults.

*Working with Adults*

Poelle (1993) asserted that early childhood educators typically lack a theoretical base for working with adults, even though they often teach as members of a team. The difficulties associated with working with adults were alluded to in the comments of a senior curriculum officer who said:

> *When teachers come to work as project officers they're coming into quite a different work environment, It holds a different work culture. There's certainly a different way of operating and they have to get their heads around a whole lot of issues. They're good practitioners with kids; they've now got to become good practitioners with their colleagues, adults. That takes a significant amount of adjustment.*

Should working with adults be an "adjustment" to skills already acquired? How do educators involved in professional development acquire the skills necessary to work with other adults? Poelle (1993) stated that it is necessary to establish a continuing support group focused on adult relationships to address significant issues such as team-teaching conflicts and coping with change. Acquarelli and Mumme (1996) claimed that many teachers lack experience in leadership and thus have little confidence in their ability to lead. They described a program where teachers were given the opportunity for "supported" leadership experiences. Leading professional development activities in mathematics education can be difficult, according to Acquarelli

and Mumme (1996), especially when working in a curriculum area where the teachers lack confidence. According to Jalongo (1991), basic assumptions about how adults learn and grow apply to teachers. She reported that teachers' self concepts move from dependency to self-direction and that planners and presenters need to take account of participants' personal needs and levels of independence.

*Contexts*

A number of writers (for example, Lovitt et al., 1990; Robinson & Alexopolous, 1986) have emphasised the importance of ensuring that professional development activities are school-based. The implication is that it is easier to involve groups of teachers (and parents) from one school, to encourage commitment by participants and school administrators, and to foster commitment and involvement of the whole school community, if the activities are school-based. Statements made by questionnaire respondents and interviewees in this study provide support for the DEET (1991a) claim that teachers prefer professional development activities to be in the form of a practical workshop located close to or in their school.

- *EMIC worked because it was in our school and each week we tried something new in our maths class and then discussed it/reviewed it with colleagues.*
- *Professional development provided by the school on the premises motivated me to go on.*

In addition to the strengths discussed, school-based professional development can also encourage or ensure the participation of all teachers in a given setting.

*Processes*

Exemplary professional development acknowledges both individual and group processes. Consideration of individuals is evident in needs assessments, individualised methods, regular feedback, opportunities for trying out new ideas and observing others (Robinson & Alexopolous, 1986; Vartuli & Fife, 1993). Incorporation of group processes implies a maximisation of collegial cooperation manifest in joint planning, working with others, sharing materials and resources (Robinson & Alexopolous, 1986; Vartuli & Fife, 1993). Group processes were found to be important to participants in this study. The sharing of ideas and resources was mentioned in questionnaire responses related to successful professional development (see Table 9). The importance of motivation to participate in professional development (see Table 10) and the need for professional development to meet individual professional goals (see Table 13) were also found to be related to successful professional development. Further, teacher interviewees identified working with others and networking (see Table 34) as positive aspects of professional development experiences. Professional development as a collegial activity is more fully explored later in this chapter. The teachers in this study also believed, as did teachers in a study in Queensland reported by DEET (1991a), that they should have a greater degree of control over their own professional development. Such control extended to both the format and content of professional development experiences as the following comments illustrate.

- *I hate inservices which are a one or two day "shot in the arm" by some expert with a bright idea about what we should be doing in our classes.*
- *I hate listening to someone talk for ages.*

Not only do such comments confirm that most teachers are not involved in planning the professional development programs in which they participate

but they also affirm previous statements about the fundamental need to take account of adult learning principles. Johnson (1990) reported that suggestions that teachers themselves are in the best position to improve education has met with favour from teachers. An important question, however, remains unanswered: How can schools can be best organised for more effective teaching and learning? We know little yet about how teachers themselves would systematically improve schools if given the chance.

*Content*

Collinson (1996) asserted that there is a need for developing teachers, not just techniques. She proposed that not only should there be an emphasis on professional knowledge (the knowledge needed for the classroom) but also that interpersonal and intrapersonal knowledge should be a feature of professional development activities. According to Collinson, teachers want information which helps them solve specific problems rather than information for its own sake (problem-centredness rather than subject-centredness). In attempting to assist teachers to solve context-specific teaching and learning problems professional development planners and providers are confronted with a dilemma: should the emphasis be on specific problem-solving strategies at the time of need or on ongoing support to ensure that teachers can apply the substantial knowledge they already possess?

*Appropriate applications of child development.* Child development is considered to be an essential component of contemporary early childhood preservice education (Gifford, 1993; Hutchison, 1994; NAEYC, 1991). Teachers seem to know, according to Weikart (1994), about child development and appropriate teaching and learning strategies, but observations in classrooms and training programs suggest that this

knowledge is applied inconsistently. Weikart asserted that philosophies presented in professional development sessions may be written down and applied in settings where the ideas are disruptive. A lack of a strong foundation in child development, especially cognitive development, and a lack of ability to apply it often contributes to lower confidence levels in teaching mathematics. For some teachers linking theoretical perspectives to their own practice presents difficulties. The difficulties teachers experience adopting or maintaining a constructivist approach has been successfully documented by Wien (1996) whose research subjects were observed moving between teacher dominion and developmentally appropriate practice.

A summary of relevant literature in a previous chapter included reference to the claim that teachers need to have a clear vision of why and how change is to occur. There are many reasons why teachers might engage in processes aimed at changing aspects of their practice and some of these were articulated by teachers in this study. One reason for change is an expressed desire to link their practice to current theory. The following extract illustrates this point.

- *Positive outcome was learning about the philosophy/theory of constructivism which fitted with my understanding about teaching and learning but for which I had not had a coherent theoretical base.*

The perceived theory-practice dichotomy remains a vexed issue in professional development. The range of teachers' perceptions of the relationship between theory and practice makes it difficult to clarify any discussion on how to achieve a balance between theory and practice in professional development programs.

*Practicality.* One of the recurrent themes in the statements of teachers in this study was found to be the relevance of professional development activities to classroom contexts. Descriptions in the literature of teacher

choice in relation to the content of professional development activities have revealed that in both Australian and overseas contexts the preferred topics for professional development were those directly related to classroom teaching and the choice of activity being guided more by its practical application than by other considerations such as recognition for accreditation or promotion purposes (see, for example, Acquarelli & Mumme, 1996; DEET, 1991a).

Teachers' interest in learning today what helps them teach better tomorrow has been referred to by Jalongo (1991) as immediacy of application. Further, research by Johnson (1990) revealed that, although teachers were generally critical of inservice activities, they found workshops valuable. This was because they could choose topics which addressed their areas of interest and choose instructional approaches that gave them hands-on experience. Such an approach to professional development was evident in this study. For example, in response to questions which asked teachers to describe successful professional development activities they had experienced or would like to plan, many teachers commented on professional development experiences which included practical classroom activities and resources (see Tables 8, 11 and 24). The following are examples of responses.

- *One on Rigby maths series—a workshop where games and useful collections were made at the inservice. This was valuable as I came away with physical things I could use immediately.*
- *Making games—hands-on, practical, useful the very next day, time to see a vast range of games and select those applicable to my class and opportunities to play/make/extend/etc.*
- *While I appreciate new/extended information, it's usually left to my own time to implement in my class opportunities to*

*make the problem solving cards, to find the place value activities, etc are usually left to teachers' own time. If people want active implementation, time must be allowed to develop necessary resources.*

An explanation of the teachers' concerns with practicality has been offered by Savage (1993). She hypothesised that there are many early childhood teachers who were graduates of kindergarten college courses which had a practical emphasis. Glascott (1994) warned that there is a danger in the trend among early childhood professionals to overemphasise the practical aspects of teaching young children without completely understanding the theory behind the practice. She argued that a comprehensive and reflective knowledge cannot be attained from instruction manuals or "one-session" conferences, and that meaningful experiences which promote children's development on a continuing basis do not originate at "how-to" workshops. Leinhardt (1990) and Acquarelli and Mumme (1996) stressed the importance of balancing the rush to capture the wisdom of practice with theoretical knowledge of learning, development and subject matter. Acquarelli and Mumme (1996) claimed that, without constant attention to the professional issues that arise out of practical experiences, the potential for helping teachers to re-examine their beliefs diminishes. Leinhardt (1990) asserted that there are tensions between the situated, concrete particular knowledge of practice and the general, flexible knowledge of theory. Some teachers in this study were sensitive to this tension as the following response shows.

*Professional development should focus on "Why?" and "What?" rather than the superficial "How?". Many professional development activities are little more than swap shops of tricks of the trade. These can be picked up in any number of "cute" books. Teachers can sort out the "How?" in their own situation using resources at hand.*

Weikart (1994) asserted that "make and take workshops" may be exciting but often lead to the development of inappropriate materials. Teachers seem to be too literal, he claimed, taking ideas at face value and applying them without regard to the needs of particular children.

In order to overcome teachers' apparent preoccupation with practicality, Hutchison (1994) suggested that professional growth opportunities should be offered at two levels of participation. One level would enhance practical "how to" skills, while the other would require discussion, reflection, and literate participant responses which merit academic credit. Such an approach has already been incorporated in some professional development programs, but ensuring the second level of participation suggested by Hutchison will continue to present a challenge for professional development planners.

*Appropriate use of manipulative materials.* A further concern for early childhood teachers is the issue of manipulative materials. The principles of developmentally appropriate practice, as documented by Bredekamp (1987), the statement made by the National Council of Teachers of Mathematics (1991) on early childhood mathematics and contemporary curriculum documents (see, for example, New South Wales Department of School Education, 1989) recommend that children aged between five and eight years should have extensive experience with concrete materials. Campbell and Carey (1992) claimed that, in general, the use of concrete models to facilitate young children's thinking has been accepted as an appropriate teaching strategy. Comments made by teachers in this study suggest that they believe this to be so.

- *For most children their hands-on experiences teach them about mathematics.*

The use of manipulatives, however, can raise some questions. Ross (1989) suggested that concrete embodiments have their limitations and may be

successfully manipulated without meaning. A manipulative may be treated as a symbol system. Children may learn the rules and procedures associated with a given manipulative material without ever establishing the link between the manipulative and the concept it is to embody. This was clearly the case for some of the teachers in this study who described examples of the inappropriate use of manipulative materials when outlining incidents where they felt children were not learning significant mathematics.

- *When I introduced children to addition on a worksheet instead of giving them "hands-on" experiences first. I should have begun with the concrete and then moved towards abstract.*
- *The children were doing sums up to 20 using Unifix cubes. I realised too late that the children did not have an understanding of one-to-one up to 20.*

Prawat (1992) used the term "naive constructivism" to describe teachers who equate activity with learning. "Naive constructivism" boils down to a kind of blind faith on the part of teachers in the ability of students to structure their own learning. The prevalence of "naive constructivism" may warrant investigation. To be specific, to what extent does the rhetoric of early childhood education with its emphasis on play, developmentally appropriate practice and child-centred approaches to planning contribute to "naive constructivism"?

*Matching teaching to resources.* Research by Johnson (1990) showed that teachers were often constrained by a lack of resources or by time-consuming or difficult ordering procedures. In her study, Johnson found considerable evidence that teachers adapt their teaching to the supplies and equipment that are available. One teacher in Johnson's study commented that the photocopier had created a whole education underground. Johnson concluded that it was no surprise that the most crucial piece of equipment in many schools was the photocopier! Teachers acknowledge that

worksheets or textbooks are not adequate substitutes for relevant, engaging experiences but justify their use with reference to factors such as time constraints or school policy.

- *I saw several examples of activity books being used as time fillers and as entire maths programs. They were colouring in "books" and I would end up sending them home barely started.*
- *Children do seem keen to do stencil-type work. I'm aware that I use this sometimes with a group while I'm working with another group. I'm uncomfortable about this but as an organisational tool it's useful.*
- *A lot of structured programs such as Rigby do not cater for individual needs as well as teacher-devised ones. Because I am a head teacher in a 2-teacher school I am forced to use schemes such as these.*

Blane (1990) claimed that teachers use textbooks because they contain activity books and blackline masters which are used so children will have something to do. Before long, Blane asserted, the textbook becomes the raison-d'être of the mathematics program. Classroom mathematics becomes the "doing" of mathematics from books and worksheets yet it takes little reflection to realise that in the real world this is not the way mathematics is "done." Ball (1996) disagreed, claiming that carefully designed curriculum materials can offer teachers access to mathematical ideas and ways to represent them. She claimed that textbooks can offer maps of the mathematical territory and help teachers to chart the terrain around the "big ideas." Ball suggested, however, that textbook writers might aim to help teachers learn mathematics by engaging them in pedagogical conversations and by encouraging teachers to use texts in innovative ways.

This view was shared by Millett, Brown and Askew (1995) who reported that commercial materials can be used in such a way that the

teacher, rather than the textbook or scheme, is firmly in control of organising the mathematics experiences which occur in classrooms. Acquarelli and Mumme (1996) warned that using textbooks often meant that teachers worked on small sections of the curriculum which sometimes diverted attention away from the whole of the mathematical experience. Teachers may attempt new units of work or lessons from textbooks or resource materials but may be disappointed with the resulting lack of coherence.

## Early Childhood Perspectives

*Establishing an Early Childhood Focus*

Recognition of the fact that teaching young children is not about scaling down experiences designed for older children often motivates teachers to seek to change their practice. This is especially so for teachers who have not been trained to work with young children.

- *I would like more activities actually aimed at the early childhood level.*
- *I would like an early childhood (4-7 years) maths inservice or demonstration. I am not trained or expert in either preschool or infant age maths. An overall picture of this level of maths would benefit me.*

Learning about working with young children is important for teachers without an early childhood background. For teachers with early childhood qualifications and experience maintaining the right to teach in "the early childhood way" is crucial as these comments indicate.

- *I would like to present a workshop like "Hands On Kindergarten Maths" to preschool teachers who have little experience working with 4-5 year olds.*

- *I enjoy teaching maths with the infants. Maths is fun and easily incorporated into other areas of the curriculum which is essential in early childhood.*
- *I enjoy teaching maths as in early childhood it is very much a hands-on activity.*

The view that teaching mathematics to young children is different from working with older primary or secondary students is borne out by teachers' comments about support personnel.

- *There is a person in the department but he is a secondary trained maths teacher and I have not seen him at my school.*
- *I sought advice once from the maths curriculum head at school but being a Year 7 teacher he was a bit lost in early childhood.*

The selection of appropriate support personnel is difficult when there is a wide range of teaching contexts to consider and often the specific needs of early childhood teachers are subsumed under the primary umbrella.

## Professional Development as a Collegial Activity

*Dimensions of Collegiality*

There is considerable support for the notion that the social and personal dimensions of teacher professional development warrant further attention (see, for example, Acquarelli & Mumme, 1996; Johnson, 1990; Jones, 1993; Winter, 1996). Collegiality is characterised, according to Romberg (1988), by teacher engagement in precise and frequent talk about teaching, observation and critique of teaching, collaborative enquiry, joint actions such as planning and preparation, and reflections about their work. Teachers also teach each other the practice of teaching.

Interactions with colleagues, according to Johnson (1990), help to meet teachers' personal needs for social interaction, reassurance and psychological

support; instructional needs for pedagogical advice and subject matter expertise; and organisational needs for coordinating students' learning, socialising new staff, setting and upholding standards, and initiating and sustaining change. The collegial aspects of teaching were mentioned frequently both in questionnaire responses and in the teacher and key informant interviews in this study (see Tables 8, 9, 11, 12, 21 24, 28, 33, and 34). The articulation of the modes of peer interactions varied from generalised "sharing" to quite specific suggestions for increasing collegiality.

*Meeting personal needs.* In response to a question which asked respondents to describe their motivation for involvement in professional development activities several teachers mentioned meeting other colleagues.

- *Opportunity to meet and share with other teachers.*
- *Meeting other teachers to review their ideas and practical situations.*
- *Opportunity to meet others.*
- *A chance to meet with other teachers—urban and rural*

Social relationships among teachers, Johnson (1990) asserted, are an important part of being a teacher. The formation of positive social relationships in professional development activities encourages teachers to tell stories based on their experiences. Greenough (1993) identified the finding of "voice" as a significant step in recognising oneself as competent. He continued that many early childhood teachers are women who for reasons of social class, race, language, culture and gender, have been denied a voice. Thus the importance of creating a "comfort zone" in which teachers can honestly discuss their teaching cannot be underestimated. When describing the professional development activity which had the most impact several teachers in this study mentioned interactions with colleagues.

- *EMIC because there was much lateral learning from colleagues.*
- *I particularly gained from sharing "maths that works" with colleagues.*

Earlier discussion highlighted the difficulties associated with achieving a balance between meeting personal and social needs and providing real professional challenges for teachers.

*Meeting instructional needs.* Jones (1993) suggested that adults, like children, learn both through being told by those who already know and through discussion with those who are also in the process of constructing similar knowledge. Lampert (1994) stressed the importance of schools making opportunities available for teachers to work together on the problems of practice. She claimed that teachers have not been treated as people who can and should think about curriculum and instruction but as people who cannot think for themselves and have to be told what to do. Again, participants in this study emphasised the role of peers in helping them to meet instructional needs. Expressed needs included

- *The opportunity to work with other teachers.*
- *Opportunities to discuss with other teachers the WA document.*
- *The opportunity to share others' ideas and work with others on various tasks was a teaching/learning experience.*

In response to a question asking about support for mathematics teaching one teacher reported:

> *I would love a chance to visit another teacher in a bigger school to observe and discuss strategies in regards to transition mathematics.*

It is evident that many teachers feel they can learn a great deal from their peers. The data from this study thus support research done by Clarke (1997) and Winter (1996) who reported that teachers identified observation of other

teachers and shared working on issues as desirable ways to work. Several other writers (for example, Leinhardt, 1994; Shulman, 1988) have described the practical knowledge of teachers' craft in which experts possess the wisdom of practice. Leinhardt cautioned, however, that not all teachers' knowledge should be considered wisdom. Craft knowledge may encompass the wealth of teaching information which very skilled practitioners have about their own practice, but it may also include fragmentary, superstitious and often inaccurate opinions.

*Meeting organisational needs.* The value of working together rests not only with meeting individual and instructional needs but it also assists in the organisation of learning as the following comments show.

- *Unit meetings—the sharing approach works.*
- *My co-teacher and I have developed a way in which we plan our mathematics activities which we are very happy with.*

Contact with experts and with peers can be formal or informal. Unfortunately not all teachers have access to colleagues who may be able to offer support. One teacher in this study reported:

> *There are people doing good stuff but sometimes they don't publicise their work so that they don't get swamped. Those in the know use these people. Others may miss out.*

Johnson (1990) commented that in an ideal world teachers would be true colleagues working together, debating about goals and purposes, coordinating lessons, observing and critiquing each other's work, sharing successes and offering solace, with the triumphs of their collective efforts far exceeding the summed accomplishments of their solitary struggles. She concluded that the real work of teaching is very different with teachers engaged in parallel piecework devising curricula on their own, ignoring the plans and practices of their peers and offering conversation as a diversion from teaching rather than as an occasion for deliberation.

*Networks.* Networks of professional colleagues provide significant pathways for communication and for the adoption of innovations. Teachers are aware of the value of establishing networks as the following teacher's comment suggests.

> *If I had the time—a maths network would be great. This could involve a group of teachers from the same school or region who meet once a month to share "What works for me" maths ideas/activities.*

Formalising and supporting teacher networks was a feature of a project reported by Acquarelli and Mumme (1996) who found that participation in a network of teachers from a broad geographic region increased opportunities for exposure to diverse ideas and provided momentum and widespread support for change. In response to a question in this study which asked which professional development activities had positive outcomes and why, one teacher stated:

> *Forming of a network made you realise you had a contribution to make and learning from others was important.*

Another teacher linked the success of a professional development experience to the establishment of a professional network. Networks are valued by teachers but sometimes, according to Romberg (1988) are difficult to establish and maintain. Typical impediments include time, schedule constraints and administrators' conceptions of the nature of the teacher's job. If these constraints are overcome then teachers may utilise their professional networks to gain confidence and support for change.

*Teaching other teachers.* Johnson's (1990) research showed that many teachers learned from training others such as student teachers, beginning teachers and peers. Assisting others in the craft of teaching can be an attractive and rewarding experience—unless the surrounding circumstances make it inconvenient or burdensome. Teachers in Johnson's study

believed that they had something to offer and could benefit from the expertise of others. Virtually no formal mechanisms, however, existed to make that exchange happen, and strong egalitarian norms discouraged any but the most unassuming assistance. Most preferred these arrangements to be on an informal basis. The comments of teachers in this study support Johnson's findings. One teacher reported:

- *I came across a lady who had taught Aboriginal children in the NT for several years. She gave me advice on an activity-based program which worked for her. I think that teachers can learn a lot from other experienced teachers.*
- *I would like to help other teachers develop and implement more "hands-on" approaches.*
- *I would like to present a workshop for preschool teachers who have had little experience working with 4-5 year olds.*

Fullan and Hargreaves (1991) claimed that a problem for those involved in school improvement activities is that there is not enough opportunity and not enough encouragement for teachers to work together, learn from each other, and improve their expertise as a community. Longmire (1994) argued that the most common state for a teacher is not collegial but a state of professional isolation where it is legitimate to work by yourself in your own space. She contended that many schools continue to reinforce this state of affairs. Architectural and organisational constraints, coupled with embedded patterns of behaviour based on the way they themselves were taught, force teachers to believe that collegiality is not a feature of the culture of teaching. When overloaded with responsibilities teachers seem to find it easier to continue with old habits of isolated work and push time for collegiality to the fringes of the working week. The valued teachers in Johnson's (1990) study knew that informal and formal interactions with fellow teachers could satisfy their needs for adult company as well as

invigorate their teaching. They looked to other teachers for personal support, for instructional assistance and for institutional coordination. This form of professional interaction is one to which teachers in this study would seem happy to subscribe.

*Support for professional development.* Fullan and Hargreaves (1991) claimed that advisorship, consultancy and curriculum leadership at the school level are beginning to emerge as alternative solutions to the problem of finding appropriate expertise for professional development activities. Elementary school teachers, according to Fullan and Hargreaves, with support from outside the school, can take responsibility for developing particular curriculum areas with their colleagues, advising their colleagues on resources and approaches, and for working alongside them to implement new initiatives. These authors contended that as teachers work under conditions which include responding to an overload of innovations and reforms, it is important that they work and plan more with their colleagues, sharing and developing their expertise together, instead of trying to cope with the demands alone.

## Teaching Mathematics

### *Teacher Backgrounds*

In earlier sections of this thesis it was argued that there were many factors which contributed to the way teachers approached their mathematics teaching and that one of the most important was teacher background (Dean, 1991; Hyde, 1989). Revisiting particular aspects of teacher background will help to highlight the significance of the personal/professional interface in professional development. Teacher attitudes and beliefs, according to Hyde (1989) and Lubinski (1994) are two of the most important influences on teacher behaviour. Specifically, Lubinski claimed that a teacher's beliefs

about students' abilities influence decisions made about the mathematical learning environment. This is evident in the following statements from teachers in this study.

- *At many times I feel like I'm wasting my time due to children, in my view, not being ready for formal school, let alone formal maths.*
- *The past experiences, learned concepts and language skills a child brings to a new maths experience determine the level of "maths" comprehension.*

The diversity of teacher attitudes and beliefs reflects the differential professional and personal experiences of teachers.

Teachers have mixed feelings about the influence of formal study on their development as a teacher of early childhood mathematics. Some had successful experiences and were able to articulate the reasons why the mathematics education subjects studied were successful for them. Others did not find their tertiary study helpful.

- *The Mathematics curriculum subject was successful because it presented theory in real life.*
- *One positive outcome of my study was learning about the philosophy/theory of constructivism which fitted with my understanding about teaching and learning, but for which I did not have a coherent theoretical base.*
- *There was very little support to see or learn about what a constructivist approach to teaching maths looks like in practice.*

Greenough (1993) claimed that a tertiary institution can be an effective partner in staff development if it is open to change in timeframes, location of classes, student services procedures, design of classes, instructional modes, and instructors' degree of autonomy. Greenhough also suggested that tertiary institutions should accept credit for off-campus work designed

collaboratively with community agencies as this would reduce the perception of exclusiveness that characterises some institutions of higher education.

Comparisons between tertiary study and other professional development experiences are often made on the basis of perceptions of the degree of theory and practice. VanderVen (1994) claimed that theory can be translated into practice, and conversely, practice into theory. In order to strengthen the articulation between theory and practice, according to VanderVen, early childhood professional preparation programs must recognise that knowledge is generated from practice which is conceptualised and related to other theories, and that theory is translated into application by a reciprocal, several-step process. For some teachers, however, the perception of theory and practice as a dichotomy is reinforced by professional development experiences.

- *The MINT inservice was the best practical inservice I attended. It left theory aside and showed various ways to make maths enjoyable.*

The perception of a disjunction between theory and practice has been found in earlier research (DEET, 1991a). A study of teachers in Queensland showed that theory was expected to be encountered in study for formal qualifications but was not expected to be of great benefit to the activities in the classroom. Batten, Marland and Khamis (1993) hypothesised that the low value attached to experiential knowledge in tertiary award courses can be blamed on the prevailing ideology in education which not only separates theory and practice but gives greater credence and legitimacy to theory than to practice. Cobb, Yackel and Wood (1991) questioned whether teachers should first be taught general theoretical principles of content knowledge before learning to apply these principles to make practical decisions. They argued that principled models of learning are abstractions made by

researchers after many hours of reflective activity. Again, the capacity for professional reflection emerges as a crucial factor in the ability to link theory and practice.

*Effective Mathematics Teaching*

Despite increased interest in how teachers teach mathematics there is no consensus in the literature, or among the teachers in this study, about what constitutes effective teaching. There are, however, some factors which are frequently mentioned in relation to successful teaching. The exploration of some of these factors in the following discussion serves to foreground issues of interest and concern to the teachers in this study.

*Theoretical knowledge of learning.* Clemson and Clemson (1994) asserted that many of the shortcomings in children's experiences of mathematics in schools may be due to overzealous adoption and adherence to aspects of developmental and behaviourist ideas. They suggested that there are a number of implications for teachers of young children, one of which is the need for teachers to recognise that eclectic theoretical approaches to teaching mathematics can be appropriate. Clemson and Clemson also suggested that the emphasis should be on extending children's horizons and not on thinking that content may be too hard or inappropriate for young children.

Cobb, Yackel and Wood (1991) suggested that a case-based approach might help teachers to develop their pedagogical knowledge. For example, if teachers were to share their interpretations of video recordings of children attempting to solve mathematics tasks under the guidance of an expert diagnostician they might build on their own informal ways of interpreting and drawing pedagogical assumptions from children's mathematical activity. According to Langer and Applebee (1986) who reviewed research on mathematics learning there are five features of authentic learning

experiences. These are ownership, appropriateness, structure, collaboration and internalisation. As indicated by the previously cited comments of the teachers in this study authentic learning does not always occur.

Teachers are, however, aware of how learning experiences might become more valuable. They recognise, for example, the value of children being involved in a variety of flexible groups such as working with same-age and cross-age partners or tutors, or working with larger groups.

- *Children learn from each other, children learn "here and now" when the moment is right; children learn by doing, through practical relevant experience.*

What children learn, according to Langer and Applebee (1986), is truly part of them because they have been actively involved throughout. This premise was acknowledged by many teachers in the study.

- *Children learn maths by DOING, TALKING, TAKING RISKS, DISCOVERING.* (emphasis in original)
- *Forever aware of the links between concrete experiences and internalising.*

The place of appropriate practical work has been stressed in many documents, particularly since the report by Cockcroft (1982). Teachers recognise the importance of practical experiences but appear not to be able to position practical work within a total teaching and learning framework. Establishing or reinforcing a coherent and appropriate teaching philosophy remains a professional development challenge. Weissglass, Mumme and Cronin (1990) formulated recommendations on the nature of activities and events which seem likely to facilitate the implementation of a constructivist philosophy. The key elements of their recommendations were the provision of mathematical learning experiences for teachers, the development of learning skills in teachers, the empowerment of teachers as learners and assisting teachers to address their own feelings about

mathematics. Weissglass et al. noted that it is a complex and arduous task to change from traditional instructional practices. Other writers have also reported that many teachers held in high regard under traditional standards are far from having established an environment that fosters effective communication. The results of this study support the notion that educators should not underestimate the enormity of the task or the commitment of time and resources which are required to implement a constructivist philosophy in the classroom. A significant component of this commitment is ensuring teachers have adequate levels of mathematical content knowledge.

*Pupil motivation.* Sullivan and Leder (1992) claimed that inservice programs should address ways to identify and improve students' attitudes to learning. Teacher educators should also emphasis that teachers need to listen to pupils and to see the formation of appropriate attitudes as a meaningful step in the learning process. For the teachers in this study it seemed that motivation was linked to making the classroom more enjoyable for children.

- *Maths was made fun and possible rather than a necessary chore.*
- *I enjoy maths and hope the children do too.*
- *I enjoy teaching maths. I try to make it fun.*

Prawat (1992) asserted that many educators downplayed the educational value of experience and emphasised, instead, the enjoyment value. According to Prawat this was an inappropriate application of the work of Dewey. He claimed that attempting to connect subject matter knowledge with the child's experience was the hallmark of Dewey's approach to education. Herein lies a potential dilemma: If teachers' subject knowledge is not strong, then are they able to make appropriate links to children's experiences and hence provide essential intrinsic motivation?

*Mathematical content knowledge.* The importance of teacher's mathematical content knowledge has been documented earlier in this study. A number of writers (see, for example, Bromme & Brophy, 1986; Fennema & Franke, 1992; Hudson, 1990) have argued that a sound subject knowledge enables teachers to convey the wholeness of mathematics. Some teachers recognise that their knowledge of mathematics, and perhaps of teaching, is ill-structured. VanderVen (1994) claimed that a simple array of interventions from which teachers can select is inadequate. Early childhood educators must know how to match a particular learning situation with their knowledge base, how to select the most appropriate intervention, how to anticipate possible outcomes, and how to do all of this quickly. Many of the teachers in this study acknowledged that their mathematical content knowledge was not strong.

- *Confident with subject matter and purposeful teaching at a low level but not confident with maths as a whole.*
- *Personally not as confident as I could be.*
- *Not confident—lack confidence and knowledge.*
- *... I often feel there is more I could do if I had more of a maths brain.*

The implications of poor content knowledge, as drawn from the comments of the teachers in this study, are many. They include inadequate attention to "weaker" areas of the curriculum (for example, measurement and geometry), inability to enhance and extend children's knowledge, uncertainty about assessment, difficulty explaining concepts to children, catering for a range of ability levels and dealing with cross-cultural issues. It would seem that teachers who felt their content knowledge was weak "cover" the necessary curriculum requirements but are often not able to meet the pedagogical challenges of contemporary classrooms.

*Reflection.* Teacher planning would certainly warrant attention in a reconceptualised framework for professional development planning in mathematics education. So too would peer observation as it seems to be potentially useful in assisting teachers to refine their reflective skills. Greenough (1993) cautioned, however, that beginning classroom observations with a focus on teacher's behaviour can be threatening, raising fears of being evaluated. Rather, classroom observations can begin with notes on children's behaviour which focuses both the observer's and the teacher's attention where it should be—on what is happening to children. In dialogue on the observations, the teacher's behaviour in the situation comes up naturally for shared reflection. Sullivan and Leder (1992) claimed that inservice education programs could assist teachers to interpret students' responses and to recognise the influence students have on the strategies teachers adopt. One way to do this may be to emphasise the need for greater self awareness and reflectiveness by teachers. Cranton (1996) agreed that explicit explanation and practice with several types of reflection could enable them to assess their teaching more accurately.

Sullivan and Leder (1992) suggested that the ability of teachers to reflect on their practice was an area which warranted further research. They stated that such research could include examination of whether beginning teachers can reflect on their teaching, whether the ability to reflect declines or increases with experience, whether reflection involves mainly students' responses, whether teachers use achievement of content objectives, for example, as a basis for reflecting on their teaching, whether the ability to reflect is a personality trait or whether it is possible to develop this skill, and whether teachers who reflect on their practice have a greater sense of purpose in their teaching than those who do not reflect. Hart et al. (1992) believed that it is not possible for teachers to change their teaching practice without subjecting their practices to thought and consideration. They

outlined a number of questions which should be answered as part of the process of reflection.

- How do I interact with students?
- How do I respond when they ask questions?
- What kind of classroom climate do I create?
- What kinds of questions do I ask?
- Is my classroom spontaneous or is it predictable?
- Why didn't a lesson go over well?
- Why did a lesson work? (p. 41)

Azumi and Lerman (1987) claimed that, as a profession, teaching is tending to lose some of the most academically able people and attracting a substantial proportion of the academically less able who may be less likely to become the reflective practitioners required in the next decade. Corwin (1993) speculated that, if teachers can reflect and do their own mathematical thinking, then they are more likely to develop both content and pedagogical knowledge of mathematics and about mathematics which in turn will nurture their reflection on teaching and learning. Doing mathematics, reflecting on mathematics, and reinventing practice within a supportive community lead to an essential element of profound and lasting teacher growth.

Hyde (1989) and Corwin (1993) concluded that teachers need mathematical experiences as learners in order to be able to reflect upon learning from the inside and to devise mathematical experiences for their own classrooms. Thompson (1992) and Jalongo (1991) observed that the extent to which experienced teachers' beliefs about teaching and learning are consistent with their classroom practice depends largely on their tendency to reflect upon their actions. Facilitating reflection, according to these authors, may be the role of the mathematics coordinator or another teacher, assuming that time commitments permit, appropriate preparations are made, and the focus aspects of changing teacher role are mutually established by the participants.

*Communication skills.* Ellerton and Clements (1991) reported that, despite recommendations that children's talk should be nurtured, teachers are unsure of their roles in relation to facilitating children's talk. This view is supported by data from this study. The questionnaire and interview responses yielded few comments about the place of communication in the mathematics classroom (see Tables 18 & 38). Where communication was mentioned it was often in relation to a perceived weakness in the teacher's use of language.

- *I rushed the introduction and may have confused a couple of children.*
- *The children didn't understand what they were supposed to do.*

Some teachers did articulate statements which showed that they valued verbal interactions in their classrooms.

- *This emphasised to me the importance of the words "Tell me what you are doing."*
- *We walked around the tables listening to the children.*

The fact that none of the teachers, in either the questionnaire responses or in the interview situation, referred to the inclusion of specific aspects of communication in their teaching or planning is significant. Group work and engagement with manipulative materials were mentioned but there was no indication of how children would work together or how the use of manipulative materials linked to small- and large-group discussions or sharing sessions. The lack of overt comment on the teacher's role in facilitating communication provides confirmation that teachers do not ascribe importance to this aspect of their teaching.

*The ability to plan and organise.* Planning and organising mathematics experiences for young children poses difficulties for many teachers. Prawat (1992) stated that many teachers, in planning for mathematics teaching, have difficulty deciding whether top priority should

go to learners' needs or to those of the curriculum. There is often a separation of the learner and the content at the time of planning as these teachers' comments show.

- *I plan through an integrated unit of work and through children's areas of interest.*
- *I think of concepts then look for and make equipment that allows for exploration of the concept.*

Prawat (1992) claimed that activities, as opposed to ideas, are the basic units and starting points for many teachers when they plan lessons. This is evident in some of the descriptions of planning provided by teachers in this study.

- *I plan from concrete activities to a set task that reflects or expresses understanding.*
- *I plan a sequence of learning activities that follow through for the whole term.*

Other teachers, however, do start their planning with clear goals in mind. Often these are derived from relevant syllabus documents which include goal statements. Prawat criticised "objectives" and interaction models of curriculum development as flawed, and "closed-system" models where the curriculum is viewed as linear and as a well-defined course to be run. This is in opposition to viewing the curriculum as a set of "big ideas"; a large map or matrix. The linear approach is one, however, with which teachers feel comfortable as these comments illustrate.

- *I start by asking "What outcomes do I want children to achieve?" I then find out what physical resources are available or attainable. I then have free play with "guided" talk to build up vocabulary about desired outcomes. Then ...*
- *I look through the curriculum objectives in my program then plan an activity the best way I could to teach those concepts.*

It is apparent that some teachers' overt references to syllabus documents is a reflection of concerns about accountability.

- *... you are constrained because of all those huge curriculum demands.*
- *I always work with children where they are ready. That is one of my concerns because I don't believe in teaching in a way that says "the curriculum says year level x they have to learn this and this. " ... one day I will be told off by the system because I am not teaching according to the curriculum.*

Jalongo (1991) and Bell and Gilbert (1997) claimed that, in the information explosion, the pressure to "cover" everything has become an increasingly insurmountable task for teachers. As teachers feel pressured to "cover" more material, children are expected to follow along. Often they do so with even less enthusiasm than weary travellers on a whirlwind tour. Jalongo suggested that one way to break out of this situation would be to stop covering everything superficially and do fewer things, but to do them well. Meeting the competing demands of syllabus requirements while at the same time catering for the needs of individual children is a challenge for many teachers.

Changes in emphasis in pedagogical thinking towards a focus on individual differences has convinced educators to get in "sync" with the child's development. This is especially evident in the practice of many early childhood educators. Prawat (1992) claimed that a pre-occupation with individual differences has led to a de-emphasis on subject matter concerns. As a result little attention is devoted to difficult issues of content selection and understanding. Many teachers believe that the best way to accommodate individual differences is to employ a variety of presentation methods and to involve students in a variety of learning contexts.

- *I try to work on a variety of areas.*

- *I try to keep activities short and varied and I try to keep materials available which are varied and interesting and fun to use.*

This is not inappropriate but it does lead teachers to emphasise the packaging and delivery of content. In their selection of content many teachers defer to so-called experts. They assume, for example, that text book writers know how to sequence and arrange content and they do not trust their own judgement. This is evident in this teacher's statement.

- *I feel that by using the maths textbook I adequately cover the syllabus and the children enjoy completing the work tasks.*

When textbooks form the basis of a mathematics program individual differences are accommodated by processing children at different rates through the same material. There is, according to Prawat (1992) no theoretical justification for this. Rather, depending on the interests and desires of the child, a wide range of mathematical ideas should be available to children, and in a variety of classroom-created contexts. Although many mathematical schemes do offer variety they tend to do this in relation to developmental ideas which have their roots in a concept of appropriateness for the age of the child, and thus each kind of activity is limited by the belief of the authors about developmental stages.

*Recognition of prior experience.* Aubrey (1994) cited personal research in English reception classes which showed that teachers plan integrated topic work, stressing the importance of play, flexibility and choice with opportunities provided for practical activities. The areas chosen, however, were ones where it has been demonstrated that children have competence. She claimed that teachers took little account of the nature and direction of young children's developing knowledge of mathematics gained in out-of-school settings. Even when teachers acknowledge children's prior experience they do not always know how to deal with this when planning

their mathematics program. This is consistent with data from this study, as these questionnaire excerpts demonstrate.

- *Many children came into my class from preschool knowing numerals, usually to 10, being able to correspond 1:1 and having a good idea what each numeral meant. Two terms later they are still "doing" number 6. The WA document suggests that numerals should not be introduced until Year 1!!! Slavish adherence to fixed year-level work does not help children learn significant mathematics.*
- *I feel my teaching has many positive aspects but also often feel a bit lost as in my opinion the WA document for Transition/1 is very basic—many kids come to school already knowing much of the content. There must be ways I can enhance and extend this knowledge.*

Research reported by Wright (1994) indicated that often teachers were well aware of the fact that many children were under-challenged, particularly in their first year at school. Cobb et al. (1991) asserted that one of the dilemmas for classroom teachers is resolving the tension between encouraging students to build on their informal mathematical ways of knowing and the institutionally sanctioned formal knowledge of the academic curriculum. Wright (1994) described the results of interviews with teachers which suggested that there exist implicit, but very clear rules about which topics should and should not be taught in a given year. Without question, curriculum requirements can lock some teachers into rigid planning regimes. For other teachers an explanation of their lack of acknowledgement of children's prior experiences may be related to the teachers' lack of awareness of the richness and complexity of informal mathematical knowledge that children bring from out of school settings and/or lack of knowledge of the way children learn mathematics. Lubinski

(1994) suggested that knowledge of content and pedagogy allow teachers more flexibility in planning. Teachers who have knowledge of various problem types and the different strategies children use have the ability to plan instruction on the basis of students' thinking. This ability includes the ability to observe children and young people, skill in recognising the stage the pupil has reached and the ability to help pupils develop cognitive skills.

*Integration.* Recent work by teacher professional associations in the United States has resulted in the formulation of a position statement in relation to interdisciplinary learning in the early years of formal schooling (National Council of Teachers of Mathematics, 1995). The statement recognises that children need to solve real-life problems and take a more active role in their own learning and that this can happen if artificial barriers among subject areas are removed. Although most early childhood teachers would articulate a strong commitment to integrated approaches to teaching and learning, the realities of implementation highlight some differences in understanding of what integration means in relation to curriculum.

- *I plan mathematics around the three strands. Firstly I look to see if I can tie some of the concepts with a theme. If so, I use that. Otherwise I just continue at beginning strand number and end at space.*
- *We operate on themes therefore if maths can be fitted into a theme we plan activities to suit eg "Jungles". Many themes do not suit maths requirements therefore we decide on a small daily unit eg shapes.*

The notion that integration should occur in the head of the learner and not in the plan of the teacher is not always apparent in classroom planning documents.

*Diversity in planning approaches.* Evans et al. (1994) identified four approaches to planning which were used by the subjects in their study of early childhood teachers' work. The first of the approaches described was the "head-in-the-sand" approach which essentially represented non-implementation or ignoring of mandated curriculum documents. If key members of staff had their heads in the sand then curriculum documents had little chance of being implemented effectively.

The second approach to planning outlined by Evans et al. (1994) was labelled "paying lip service." This was described as a defiant, almost grudging approach which some teachers perceived as a means of coping. It was exemplified by token gestures, by partial, measured implementation. Teachers adopting this approach were very selective with respect to what they were prepared to take on. What generally happened were cosmetic changes. Paying lip service enabled teachers to appear to be meeting statutory obligations, even where, for one reason or another, they were not committed to doing so. It also allowed them to convince themselves that they were protecting their own professional priorities.

The "common-sense" approach to planning, as identified by Evans et al (1994), was where teachers made conscientious efforts to accommodate new curriculum documents but the process was controlled by either the realistic expectations of headteachers or by limitations imposed by teachers themselves. In essence, the common-sense approach enabled teachers to accept the changed objectives of new curriculum but to incorporate existing practices where they were appropriate.

The final approach, entitled "by the book" or a "syllabus-bound" attitude represented an uncompromising rigidity and pressured commitment towards delivering the contents of the subject documents to the last letter and, out of fear of running out of time, to the exclusion of what may be termed "non-regulation" activities. This particular approach

manifest itself in a lack of spontaneity in selecting learning activities and rigid planning, record-keeping and timetabling. Evans et al. (1994) asserted that the degrees of implementation of these four approaches generally seemed to have been determined fundamentally by the attitudes of principals to curriculum documents. In the discussion of the planning approaches used by the teachers in this study examples of all of the categories of Evans et al. are evident (see Chapter 6). What then, in professional development terms, can be done to ensure that all teachers are confident in their ability to plan in flexible and creative ways which genuinely meet students' needs? The implications for professional development will be pursued further in the next chapter.

## Challenges and Change

*Attitudes to Change*

Personal resources such as knowledge, skills and beliefs affect the actions of teachers and are particularly salient in times of change (Prawat, Remillard, Putnam & Heaton, 1992). Education reformers sometimes require teachers to do more than change the way they teach. They are also expected to change their views about students, the teaching-learning process, and the nature of subject matter knowledge (Prawat et al., 1992). In relation to research which documented teachers' willingness to change Weikart (1994) reported that there is a sequence which facilitates teachers' involvement in the change process. Learning to arrange the classroom in meaningful child-centred areas and organising teaching materials are low-risk changes for teachers, according to Weikart. These steps make teaching easier and are quickly integrated into practice. The impact on children is obvious as evidenced by reduced behaviour problems. In such a climate, teachers are encouraged to experiment a little more.

Asking children to make choices and then supporting their choices is often threatening to teachers; learning to share control of the learning process is also threatening. Learning to see and understand the developmental processes in individual children's behaviour which undergirds daily classroom practice and individual children's learning is most difficult. The emphasis on practical activities and teaching materials contained in the statements of the teachers in this study provides support for Weikart's (1994) point of view. Many teachers attempt and succeed in refining their teaching processes but how many master the most difficult stages of reform? Perhaps this should become a professional development focus: understanding and extending individual child learning.

*Support for Change*

*External support.* Within state and territory departments of education external support services for teachers have decreased in the past decade. Interviews with professional development personnel in this study revealed that there had been a trend away from specialist support staff to more generic assistance (see Chapters 5 and 6). Gifford (1993) identified the absence of early childhood advisory staff as a challenge for early childhood educators. She reported that, as school systems have dismantled their central support systems, specialist early childhood advisory positions have been removed. Increasingly the support positions that remain tend to be generalist ones, offered to all teachers across all sectors from preschool to secondary level. Further, in some schools the teachers who work with young children may not have an early childhood education background. Such was the case in this study. These trends have particularly disadvantaged early childhood teachers, already isolated and working in environments which can either be indifferent or positively hostile towards early childhood approaches to teaching.

Thomas (1992) reported that, although mathematics education may have been a government priority in principle, support for its development actually declined in the late 1980s. Until a few years ago the states and territories had considerable resources invested in research and development, curriculum projects and the professional development of teachers. The mathematics educators employed in ministries and in regional education centres maintained close contact with schools and with tertiary institutions. External support was expected and provided. As previously discussed, however, external support did not necessarily influence long-term change.

Schubert (1991) claimed that the supervision and staff development literature increasingly recognises today the empowerment that accrues when "outside experts" realise the need to share authority with "inside" experts, those who can relate their daily practice to a particular set of circumstances—in particular to a situationally-specific context. This view is certainly supported by participants in this study. Curriculum is an important area of conflict and struggle in schools according to Prideaux (1993). The literature shows that this conflict is unlikely to be resolved by processes which relate to consensual decision making. Making decisions about professional development priorities is a skill which is not necessarily possessed by all stakeholders and involves processes which might also warrant professional development attention.

*Internal support.* Docker (1987) claimed that the school had a responsibility to support individual teachers by paying attention to adult learning characteristics, using adult learning theories, using knowledge of processes or strategies to obtain change, applying knowledge about what has been learned about motivation, and providing a supportive climate. Leadership from the principal is considered a key factor as these comments from a senior education officer show.

*The principal ... actively encourages it [professional development] through establishment of a committee structure to oversight implementation of curriculum ... the principal will be talking about teamwork activities and collaborative learning, all of those sorts of things, not just in an educational sense, but also in a personal sense.*

Research by Nias (1986) showed that the major source of support for teachers was colleagues. She classified the assisting teachers as role models and professional parents. Role models tended to be teachers who were in nearby classrooms, had taught in parallel classes or shared a team-teaching situation. Professional parents were described as more experienced colleagues, consultants, university lecturers, teachers from other schools or perhaps teachers' centre staff. Nias concluded that, although these more experienced teachers were valuable in terms of the survival and craft learning of their newer colleagues, their influence was, in the broadest sense, conservative. The solutions they offered and the advice they gave were usually time-honoured and pragmatic.

Data from this study suggested that sometimes support is lacking in leadership positions. Some schools do not promote professional development adequately. These schools are known to those involved in the organisation and support of professional development.

*There are certain people in the school have responsibility to see that teachers take on board responsibility for developing their teaching. And that's generally the principal or assistant principal. Now that's fine where you've got people who are willing to do that ... but often one of the difficulties is that the principal, the assistant principals are the very ones that require development themselves, and they play what we call a gate-keeping role where they keep people away from teachers, protect teachers.*

Obviously a lack of commitment from senior staff inhibits a corporate approach to professional development.

*Follow up.* Follow up is considered to be a vital aspect of professional development but is one area which is frequently neglected. A DEET (1991b) report claimed that:

- teachers are not concerned about this aspect of professional development activities;
- it is an area of major neglect in schools;
- it should be addressed before participation in the activity;
- teachers ignore follow through when selecting their activity;
- teachers tended to assume that other teachers would learn from observation;
- staff meetings as follow-through were futile and time-wasting;
- work through mutual interest groups or support groups is most beneficial (places an expectation on participants to apply their knowledge);
- circulation of materials, though considered worthwhile, sometimes led to "out-of-context" misuse of the professional development activity.

If the DEET (1991) findings are juxtaposed against the findings of this study, then several inconsistencies are evident. For example, the teachers in this study were concerned about follow-up. They also found staff meetings with presentations from peers valuable professional development activities. The contrasting results may be because the questions in this survey were open-ended so that responses related to follow-up were not directly solicited, or, comments relating to follow-up were given as a result of a request to rate elements of professional development.

*Obstacles to Change*

Hall and Oldroyd (1991) discussed two perspectives on blockages to change. The first perspective involved the identification of three types of barriers to change; technical, value and power. The second perspective involved the characteristics of settings, change strategies and changes which are likely to lead to resistance to change. They argued that in settings where

- morale is low
- change agents are not respected
- there is a track record of failed innovation
- risk-taking is discouraged
- leaders are inflexible in their attitudes and
- there is little outside support

teachers will be less motivated to support *change strategies* which

- are unaccompanied by practical training and support on-the-job
- do not adapt to developing circumstances
- do not recognise local needs
- offer no sense of collective "ownership"
- do not build a critical mass for change.

Neither will they commit themselves to *innovations* which

- are not seen as beneficial
- cannot be clearly understood
- are at odds with their professional beliefs
- are inadequately resourced. (p. 42)

The data presented in this study include references to all of the factors contained in Hall and Oldroyd's summary and confirm that these are the key barriers to change in an early childhood setting. In particular, a lack of recognition of local needs was frequently cited as a reason for the lack of success of some professional development enterprises. What is perplexing, and perhaps could serve as a starting point for further research, is why knowledge of how change is facilitated and inhibited has not contributed to more effective professional development planning.

Johnson (1991) described one of the tensions of teaching as being the solitary endeavour of focusing on one group of students and the role of a staff member considering education in the school as a whole. Collegiality is often thwarted by the withholding of time, lack of encouragement, and lack

of responsibility to work collegially. Leadership is a critical factor here. This is evident in the comments of a senior education officer who stated that:

> *Sometimes principals excuse people from involvement rather than finding ways of involving them.*

Some teachers choose to remain distant from their colleagues, either out of disregard for them, reluctance to share ideas, or fear that shortcomings might be exposed. Jalongo (1991) claimed that many researchers have concluded that teachers are usually isolated from one another both physically and psychologically and that there is little in the school environment that encourages teachers to change from conventional practices. Teachers rarely have opportunities to come together to discuss curricular and instructional concerns. In addition, Jalongo (1991) and Acquarelli and Mumme (1996) agreed that most teachers do not feel that they receive genuine support from their fellow teachers. Change is difficult in a work environment which does not professionally nurture the individual and the group.

Hyde (1989) claimed that there were a number of obstacles to the implementation of substantial changes in curriculum and instruction in relation to mathematics education. Many of the factors cited by Hyde were mentioned by participants in this study. The factors included teacher isolation, lack of support, assistance or feedback to improve teaching and the fact that teacher evaluation was often viewed as more important than instructional improvement. Another obstacle to change, evident from the comments of teachers in this study, is the nature of teaching in primary schools. Being generalists, primary school teachers are expected to master the content and pedagogy of a range of curriculum areas and this is a major challenge during a period of considerable change.

The data presented in this study do not enable the clear articulation of future directions for professional development which aims to support teachers in their quest for improving the quality of their mathematics teaching. Rather, it highlights the complexity of factors which must be considered when planning activities to support change. The discussion has focused on some of the issues and concerns of early childhood teachers in relation to refining and upgrading their skills and knowledge. The teachers' descriptions of their practice contain statements which demonstrate that despite a wealth of literature and research which identifies the characteristics of exemplary professional development there is still scope for improvement. The challenge for professional development providers is to listen to teachers' voices and to use their stories to inform future professional development planning.

How this planning might occur is the focus of the final chapter of this work. The major threads of the discussion are drawn together in three key areas. First, there is identification of dilemmas which emerge in the light of the literature, prior research and the data from this study. Second, there is a list of recommendations which emerge from the research and finally there are suggestions for further research.

# CHAPTER 8

# CONCLUSION

## Introduction

There is an alarming tendency in education circles to oversimplify complex problems and, as a direct consequence, assume that simple solutions may be appropriate. With regard to mathematics education this tendency is manifest in the claim that the problem is "current practice" and that the solution is to "expand and improve that practice" through more appropriate models of professional development (Siemon, 1989). Reductionist views, however, often focus on exemplary programs at the expense of "the big picture" and the roles of individual teachers in the change process. The tension between large-scale public reform and the personal struggles of individual teachers as they attempt to improve their practice underpins much of the discussion in this thesis. The data presented in this thesis supports the views of many writers (see, for example, Booth, 1990; Putnam et al., 1990; Wolfinger, 1988) that change is needed in early childhood mathematics education, and that inevitably, at the heart of the education change movement, is professional development: proselitysed as a panacea and under pressure to perform.

## Where Have We Been? Charting the Territory

This study set out to investigate the mathematics education professional development of early childhood teachers. Three major themes provided the basis for the framework used to structure the literature review and the data collection. The development of the first theme, professional development, included an examination of traditional approaches to professional development. It was argued that there were many reasons why

professional development had failed to influence long-term change. New principles for professional development were summarised and examples of the characteristics of exemplary professional development programs identified. It was also claimed that many Australian teachers are now involved in experientialist approaches which focus on practice at the school level and direct attention to the processes of contextualising general policies and practices. In addition, these approaches include the documentation of the place of individuals working collectively, and draw attention to the ethical questions pertinent to school improvement, albeit generally within the discourse of an employing authority.

The second of the themes pursued in this study was early childhood education. The philosophical and historical background to early childhood education in Australia was briefly described to situate one of this study's foci: the extent to which teachers' beliefs and practices in relation to working with young children has an impact on their teaching of mathematics. It was suggested that many early childhood teachers articulate beliefs in developmentally appropriate practice, the value of play and recognition of children's prior experiences but that their classroom practice often reflects more traditional approaches to early childhood education.

The exploration of the final theme, mathematics education, included a precis of developments in mathematics education in Australia over the past twenty years and the extent to which research findings relating to constructivist approaches to teaching and learning have infiltrated both professional development and classroom practice. In the discussion of early childhood mathematics classrooms attention was paid to contradictions often evident in practice such as a stated belief in manipulative materials but frequent use of worksheets and textbooks. The author claimed that there is a plethora of research which identifies characteristics of successful mathematics teachers and successful mathematics education professional

development but that there is also a substantial body of literature which documents the reasons why teachers may not always adopt or maintain best practice.

*Research Questions*

Support for the initial tentative hypotheses was sought through data collection based on the following two major research questions:

1. What are the major elements of early childhood teachers' past personal and professional lives that are relevant to their current mathematics teaching?
2. How have teachers' professional development experiences influenced the formation of knowledge, attitudes and interests in relation to mathematics teaching?

These major questions were supplemented by others which were outlined in Chapter 4 and aimed to provide further details of teachers' professional lives.

*Summary of Results*

Analysis of a variety of data collected through interviews, document analysis and the administration of a questionnaire revealed that there are many factors which influence teachers' current teaching behaviour. The impact of formal award study and professional development activities was variable and often dependent upon the relevance of the experience, the potential application to the participants' teaching contexts and the appropriate balance, according to the participants, of theory and practice.

The representation of the theory-practice interface as a dichotomy was an indication of the teacher-participants' concern about the importance of having practicality as a fundamental component of professional development experiences. A further reflection of this concern was evident

in the reporting of the social and interpersonal dimensions of professional development experiences. Significant individuals, in the form of professional development facilitators or colleagues, played an important role in boosting teachers' confidence and assisting them through periods of change. Frequent references to the value of collegiality suggested that this aspect of professional development planning and implementation is important to teachers, and that colleagues can provide the practical, contextual support sometimes reported as lacking in formalised professional development activities. Caution should be exercised, however, when generalising on the basis of teacher responses which highlighted the importance of collegiality. In this study there were also many teachers who did not consider collegiality significant in their professional lives.

## Theoretical Significance of the Study: Divulging Dilemmas

To suggest that the results of this research could lead to some irrefutable conclusions about the professional development of early childhood teachers would be unrealistic. Rather, what has emerged from the analysis and discussion of the data are a series of professional dilemmas which appear to muddy the waters instead of indicating a clear path for reform. Anderson (1996) claimed that there are many curriculum reform dilemmas and that the interactions between them prohibits the formation of a complete picture of professional change. The dilemmas highlight the problems associated with viewing issues from multiple perspectives and suggest that meeting the needs of all stakeholders is extremely difficult.

### *Professional Development for the Twenty-First Century*

Any review of literature related to contemporary professional development provision inevitably contains references to the importance of

identifying and meeting the needs of individual teachers. In practice, this aspect of professional development planning and implementation is fraught with difficulties and highlights some of the dilemmas which arise when dealing with a large and diverse professional group. In this study analysis of the data revealed a range of such dilemmas for professional development planners and providers.

The first dilemma which emerged related to the age and experience of the participants in this study but also translated into an issue for the wider teaching community. The teacher life cycle literature cited in the Literature Review (see Figure 3) contained a number of references to mature, experienced teachers achieving stages of professional growth characterised by consolidation and comfort. Instead of consolidation and comfort, however, many experienced teachers feel pressure to abandon well-established practices and adopt new, less familiar approaches. Herein lies the first dilemma. How can the experience and expertise of ageing teachers be acknowledged and utilised while at the same time encouraging the same teachers to engage in risk-taking and challenge? To what extent is it reasonable, from both personal and professional perspectives, to undermine experienced teachers' confidence by placing them in the position of learner in a discipline area in which they may not feel confident? The notion of schools as communities of learners is well documented but for many teachers support for them as learners is not a reality. Should teachers be expected to engage in change processes without support?

Not only is the teaching service ageing but in primary schools it is predominantly female. There are additional professional development issues for female teachers (Maclean & McKenzie, 1991). These include overcoming access problems such as child care and gaining confidence in the area of mathematics. Ball (1996) reported that many female teachers have poor backgrounds in relation to mathematics and this may affect their

willingness to embrace change in teaching mathematics. The teachers' own feelings of inadequacy and incompetence, according to Ball, make it easier for them to cling to the methods used when they were learning mathematics. The dilemma for professional development providers is what to address first, the personal background and attitudes of the teacher, or the methods being used. Either way, gaining teachers' confidence and encouraging change is crucial.

A further dilemma relates to professional development sites. As the funding for centralised professional development has decreased in Australian states and territories the organisational focus for professional development has become the individual school. Literature highlighting the advantages of work-based professional development includes references to context, convenience and relevance to the daily work of the teacher. Single-site reform is considered to be longer lasting and to have more impact than large-scale generic programs. Evidence from this study provides support for the view that workplace learning is indeed valued by teachers. At times it seems convenient, however, when providing a rationale for the devolution of professional development responsibility, to overlook the weaknesses of context-driven reform. Little consideration is given to the factors which contribute to unsatisfactory experiences for teachers. The commitment and experience of the principal, the prevailing corporate climate and the degree of support available may influence the success of change processes in an individual school. Should teachers be disadvantaged in relation to their professional growth by their location and the priorities of their specific workplace? What constitutes a reasonable balance between single-site reform and exposure to any larger reform agenda, and how is this balance achieved? Dilemmas such as these have not been reconciled in the discourse of education change.

Further, decisions about appropriate sites for professional development need to take into account of the fact that teachers who may already be disadvantaged by virtue of their geographical location may be further disadvantaged by the fact that they work in small staff teams (sometimes, in fact, alone) and access to other colleagues in face-to-face situations is extremely difficult. A solution already enacted is to provide an increase in the technological facilities which enable other forms of collegial interaction to occur. Access to Internet websites and chat lines may provide additional support for teachers but perhaps this creates a further dilemma: If collegiality, apparently valued by teachers, is encouraged at the same time as greater responsibility is placed with individual teachers for their own professional development then is it possible for *any* monitoring of the quality of the professional support received, to take place?

*Resolving Conflicts in Teaching*

Discussion in this thesis has argued that constructivist approaches to teaching mathematics have underpinned most mathematics education professional development programs in the past decade. The data presented have also supported research which indicated that the adoption of constructivist principles often poses difficulties for teachers. Cobb et al. (1991) proposed that any attempt to help teachers develop forms of classroom teaching compatible with constructivism must take seriously the contradictions that teachers have to cope with in the course of their work. In particular, it must acknowledge that instructional decisions based solely on analyses of students' mathematical knowledge will often be at odds with the institutionally sanctioned goals of instruction.

Ball (1996) added that no matter what sort of research is done in the future teachers will continue to confront uncertainty on a daily basis. She outlined a number of challenges for teachers of mathematics. The first is

the challenge of competing commitments such as the commitment to teach worthwhile content with intellectual integrity while also honouring a commitment to recognise and develop the ideas of students. Anderson (1996), Jalongo (1991) and Katz (1997) also discussed the problems teachers confront when dealing with decisions about coverage of content versus depth of understanding. All of these authors asserted that it is difficult for teachers to believe that children will not be disadvantaged educationally by omitting any topic. The "preparation ethic" described by Stake and Easley (1978) appears to be deeply ingrained in the culture of schools. It is apparent from the comments of teachers in this study that finding out what should be done to further children's understandings is often outweighed by the pressures to conform to system-based and school-sanctioned messages about curriculum expectations. Is it sufficient, therefore, for promoters of curriculum change to deal with content and pedagogical issues without delivering possible solutions to the potential conflicts which arise when teachers attempt to deal, in a genuine manner, with children's learning?

*Moving Forward in Mathematics Education*

Descriptions of exemplary mathematics teaching exist not only in the relevant literature but also in the minds of teachers. Data from this study suggested that teachers are able to identify practices which support and hinder children's learning. Why then, should there be a problem in relation to improving practice? Surely, if teachers understand what works and what does not, then, after reflection, they should be able to refine their approaches to teaching. Perhaps it is a question of priorities. For teachers, ensuring that the experiences presented are relevant, practical and interesting may assume greater importance than establishing that their own content base is secure. Relevance and practicality may also be perceived by teachers as a higher priority than having an appropriate understanding of

some of the cognitive processes in which the children may engage. As has been suggested earlier in this chapter, successful solutions to professional development dilemmas may not necessarily mean more is better; possible solutions may rest in a reorganisation, or renegotiation, of priorities.

*Moving Forward in Early Childhood Education*

Wright (1994) suggested a number of topics which should warrant further consideration by mathematics educators with an interest in the early years of school. These notions included, according to Wright, readiness, developmental learning, children's autonomy, "anti-interventionism," constructivism and discovery learning. Data presented in this study were consistent with Wright's work; early childhood teachers in both studies felt that they had quite specific needs and problems in relation to their teaching of mathematics. On one hand early childhood teachers were found to articulate philosophies which included commitments to play, the use of manipulative materials, acknowledging children's prior experiences and teaching with a firm developmental basis. On the other hand, however, the data revealed how the same teachers used textbooks and worksheets, attempted to introduce formal written symbolism early in children's formal schooling and were concerned about accountability and assessment. Once again, there is no question that teachers know what approaches they *should* be adopting; these are well documented. What is missing in mathematics education professional development, it seems, are explanations of how an "early childhood philosophy" can coexist with school-based, system-driven curriculum demands. The more recent documentations of the application of developmentally appropriate practice in school settings (see, for example, Wien, 1996) have not filtered into the sphere of influence of many early childhood teachers where they could provide the psychological impetus and the pedagogical modelling to facilitate change.

## Recommendations In the Light of Literature and Research

In the previous sections of this chapter the author suggested that any conclusions about the mathematics education professional development of early childhood teachers should be tempered with reservation. The presentation of dilemmas still to be resolved serves to demonstrate some of the inconsistencies between the theoretical assumptions upon which the study was based and the realities of a dynamic research context. The result of any mismatch between theory and results is inevitably to point to ways in which there might be greater fusion of guiding principles and action. Some recommendations in relation to this study follow.

*Refining the Organisation of Professional Development*

Despite extensive documentation of exemplary professional development activities further refinement is needed in some areas. Ball (1996) and Anderson (1996) claimed that there are powerful disincentives for teachers to engage in any reform agenda. Some of these are related to the ways in which teachers create their professional identities. The perceived, or real, necessity to defend, to parents and administrators, initiatives which may not have been confidently embraced or fully mastered is a high-risk enterprise. Being an agent for change is difficult, particularly in a context which may not typically reward or encourage innovation. Eraut (1993) asserted that the proliferation of literature on change processes has demonstrated that it is possible to adopt re-educative approaches which maximise teacher involvement in the implementation process. The implications for teacher development, according to Eraut, are that considerable attention should be given to getting teachers to understand the assumptions about pupil needs which underpin proposed changes and that maximising teacher involvement in planning and

implementing teacher development will enhance commitment and ownership. He warned, however, that there is a risk of "need overload" unless key principles are followed. These are

1. Change should be managed and phased so as not to put impossible demands on a person at any time.
2. Each professional development activity has to be resourced and supported at a level that gives it a reasonable chance of achieving its purpose.
3. Negotiation ought to take place, preferably with each individual teacher, about the proper balance between the school or district supporting teachers' personal needs and the teacher supporting the needs of the school. (p. 31)

Other writers such as Anderson (1996) also supported the claim that change processes take time and need to be supported by all stakeholders. A further area for refinement of teacher professional development, according to Hutchison (1994) is the requirement for quality assurance regardless of the program provider. There is also a need to challenge traditional assumptions about incentives and to facilitate articulation between professional development activities and formal tertiary award programs. This would necessitate greater co-operation between agencies involved in professional development. Any improvement in the organisation of professional development would also require overt administrative and financial commitment to appropriate programs at both system-wide and school level.

*Appropriate Professional Development Activities*

Data presented in this study and elsewhere suggested that the range of professional development activities provided in the past has been limited. Alternatives to school-time inservice have been suggested by both the participants in this study and a number of writers (for example, DEET, 1991a; Hatfield & Price, 1992; Jones, 1993). These include:

- greater use of pupil free days;

- greater use of stand-down time;
- week-long training sessions during holidays;
- sessions with parent volunteers to construct materials;
- videotaping of teaching demonstrations;
- work experience in alternative professional development contexts;
- greater flexibility with leave without pay;
- more involvement with teacher educators;
- greater level of provision by professional associations;
- teacher release by working on part salary;
- 3-5 day conferences with attendance contributing towards a degree or diploma;
- summer workshops for teachers plus continued staff development throughout the year;
- pairs of teachers in semester-long inservice program involving released time and volunteer time.

The implications of increasing the range of professional development options are that there would need to be a more coherent framework for planning at system, local district and school levels. In addition, individual teachers might be asked to construct professional development plans which outline their preferred options and suggest how these might fit within the broader picture.

*Collegiality*

Anderson (1996) reported on research which showed that collaboration among teachers was a major factor in productive change. He indicated that the most influential collaboration was in the everyday workplace and that this should be encouraged. Certainly, teachers in this study reported on the favourable aspects of working with other colleagues. If collegiality is to be encouraged then more attention needs to be paid to the ways in which it is

enhanced. Sharpe et al. (1997) argued that establishing what is meant by collegiality is a first step towards establishing and maintaining collegial relationships. They described colleagues, that is, teachers who genuinely co-operate with peers, as individuals portraying the following attributes:

- engaging in continuous, concrete and precise dialogue about ongoing teaching activities;
- observing one another in practice and providing feedback;
- planning, designing, studying, and evaluating curriculum;
- teaching one another what each knows about teaching and learning.

It is evident from this description that important elements of collaboration are an equal sharing of, and improvement upon, one another's professional activities and a strong partnership ethic.

The prerequisites for collegiality, according to Johnson (1990) are good and generous teachers, organisational norms which place value on collaboration, reference groups, sufficient time for interaction and accommodating administrators. This does not occur without a deliberate effort to foster professional relationships. Schools which take the time and effort to do this, according to Dalton (1997), reap many rewards in relation to teaching and learning.

## Limitations of the Study and Areas for Further Research

The significance of this study is not confined to its confirmation of the strengths and weaknesses of past and present professional development provision in relation to early childhood mathematics. Identifying the concerns and interests of individual teachers also illuminates the wider theoretical issue of teaching in general in the 1990s. More specifically, detailing dilemmas and conflicts in teachers' professional lives has

highlighted the interrelationships between personal and professional growth, between pedagogical and content knowledge and between teaching for understanding and covering the curriculum. In addition, the study has probed the basis of the philosophical underpinnings of early childhood education and of the implications for practice in the school setting.

Although the data collected enabled discussion of a wide range of issues related to the work of early childhood teachers, professional development, and mathematics education, there are a number of limitations to this study. The first of these relates to the size of the sample. There was a high non-response rate to both the first and subsequent distributions of the questionnaire. Evans et al. (1994) claimed that one problem in a small-scale study which included interviews was to know whether the eloquent quotes provided by the interviewees actually represent a view widely held in the profession. More efficient follow-up procedures should have been employed to increase the sample size. In addition, the size of the questionnaire and the large number of open-ended questions required a substantial time commitment which was obviously too great for many potential respondents. A further factor which could have contributed to the response rate was that the questionnaires went to school principals for distribution. If the names of early childhood teachers had been obtained and the questionnaires mailed directly to them the response rate may well have been greater.

Another limitation of the study was the relationship of the researcher to the participants in the study. The data collection components of the study were conducted in the Northern Territory which has a small teaching population. The researcher, having worked in preservice and inservice education in the Northern Territory for seven years prior to the data collection, was known directly or indirectly to most of the participants in the study. A positive aspect of this relationship was that it enabled easy access to

the key informants and encouraged questionnaire responses from participants known to the researcher. It also meant that teachers who were interviewed felt at ease with the researcher. A drawback, however, is that participants may have provided responses which they felt were expected and may have withheld some information they may have felt could have embarrassed themselves or others.

A further disadvantage created by the small sample was that it was not appropriate to carry out detailed statistical inference analyses on data derived from the study. This, however, was not a goal. A compensation for the lack of statistical data was the richness of the descriptive data obtained from participants. This did enable a more detailed examination of teachers' perceptions of their professional development and mathematics teaching experience.

The sample size also prohibited any valid comparisons of the responses of teachers from particular sub-groups. For example, it may have been worthwhile to determine if there were differences in approaches to planning for mathematics on the basis of age or experience or if the expressed professional development needs of teachers who had recently completed post-initial award study differed from those of teachers who had not completed any post-initial award study. Such cross referencing would add further depth to the discussion of results.

The presentation of data which showed relationships between different sections of the questionnaire might have been enhanced by the use of a computer analysis program such as NUDIST. The use of NUDIST was not considered to be an option at the time of commencing this study because access to training and support in its use was limited. After the data collection was completed and the interview transcripts and questionnaire responses reviewed the author felt that manual coding within the analysis

frameworks described enabled satisfactory categorisation of data. The sample size enabled close and detailed scrutiny and organisation of data.

## Suggestions for Further Research

As previously mentioned the response rate to the questionnaire may have been affected by the number of questions and the requirement for descriptive information in responses. Further research could be more focused and the range of questions limited. For example, the final question of the questionnaire was open-ended and related to teachers' suggestions for planning a professional development activity. This question alone, with a larger sample size, would provide adequate data for a full discussion of what teachers value in relation to their own professional growth.

The sample could also be limited according to other variables. For instance, access to professional development was an issue to some participants in this study because of their location. Hence, gathering information solely from geographically isolated teachers would provide a very different discussion focus. Similarly, references to the particular needs and interests of older teachers suggested that research which specifically targeted teachers over, say forty, might yield data relevant to the professional development needs of an ageing teaching population. Other writers (see, for example, Howse, 1991; Maclean & McKenzie, 1991) have claimed that insufficient attention has been given to the growing, recurrent educational needs of an ageing teaching force.

The frequency of references to collegiality by participants in this study was not anticipated and indicates another area which warrants further research. An investigation of collegiality as a factor in professional development might focus on how colleagues support other teachers or, perhaps more importantly, how teachers perceive that collegiality might be

nurtured. As well, research which does consider how teachers work together to effect educational change might be extended to include the notion of formal and informal mentoring.

The interplay of early childhood philosophy and pragmatic approaches to curriculum implementation suggest that this is an area which troubles many teachers. There is recent research which documents teachers' attempts to apply the principles of developmentally appropriate practice in school settings (see, for example, Wien, 1996) but it would appear that this could be extended so that teachers are able to see a range of applications of what they consider to be the essence of early childhood practice.

Specific examples of how to reconcile fundamental beliefs about working with young children with contemporary curriculum need to be explicitly recorded. In relation to teaching mathematics in early childhood classrooms teachers appear to need assistance in moving children from play experiences and manipulation of concrete materials to use of appropriate mathematical language, relevant recording and eventually, mathematical symbols. This would imply that there is a need for further research which fully documents how and when teachers provide the links between the various types of experiences

Anderson (1996) reiterated the point that reforms in curriculum are difficult and time-consuming. He reported that teachers may be convinced that a constructivist conception of learning is an appropriate goal, but that conviction in itself does not mean that they know how to teach accordingly or that there is the essential "how to ..." support necessary to apply the new orientation. An investigation of how teachers go beyond adding group work, or practical investigations, or writing problems, to teaching in a manner which develops real understanding would appear to be another area which warrants further research.

## Conclusion

Components of experiential approaches are evident in the descriptions of the professional development experiences of the teachers in this study. There is, however, more work to be done to ensure that all teachers have experiences of the kind outlined by Logan and Dempster (1992). Effective professional development must travel a distance of uncertain length for each participant—from the safe personal to the dangerous personal; from the certain, observable concrete to the uncertain, judgemental abstract; from the teacher as monarch to the teacher as participant (Weikart, 1994). Increasing the danger level of the professional development journey is one of the challenges for future professional development provision.

Encouraging teachers to take risks to extend their professional growth is one of many challenges which have been identified in this study. After surveying relevant literature related to professional development and mathematics education, many possible reasons why change in mathematics education has not been as widespread and powerful as might be anticipated have been outlined. Recognition, by researchers and teachers, of factors which contribute to effective professional development and to exemplary mathematics teaching is not, in itself, sufficient to influence change. As the discussion in this thesis shows, the educational change process is complex and teachers alone should not shoulder the blame for the perceived failure of any change initiatives. Further, Jennings and Dunne (1997) claimed, the educational community should celebrate the successes of teachers in improving attitudes and motivation towards mathematics and build on this success to raise standards.

The results of this study suggest that change is possible if teachers' professional and personal contexts are such that they are encouraged and supported in their endeavours to improve their practice. The challenges for

professional development, if meaningful and lasting change in early childhood mathematics education is to occur, are many. All stakeholders will need to have some responsibility and accountability for change and to work together to maximise opportunities to ensure that ultimately, young children are able to be successful and confident as they think and work mathematically.

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## APPENDICES

## APPENDIX A

## EARLY CHILDHOOD MATHEMATICS EDUCATION PROFESSIONAL DEVELOPMENT RESEARCH PROJECT

SECTION A : PERSONAL INFORMATION

To assist in the analysis of responses to questions on the following pages general background information is required for each respondent. Please tick the appropriate boxes or write in the information required.

1. SEX Male ☐ Female ☐

2. AGE under 26 ☐ 41-50 ☐
   26- 30 ☐ 51-60 ☐
   31-40 ☐ 61 + ☐

3. How many years have you been teaching?
   less than 2 ☐ 11-15 ☐
   2-5 ☐ 16-20 ☐
   6-10 ☐ 20 + ☐

4. What is your present position?
   Band 1 ☐ Band 3 ☐
   Band 2 ☐ Master Teacher ☐

5. For how long have you been at the level specified in question 4? _____years

6. What Year level do you currently teach? _____

7. Which school system do you work in?
   Government ☐ Catholic ☐ Non-Catholic Independent ☐

8. What is the location of your school?
   Urban ☐ Rural ☐

9. What teaching, academic, and other qualifications do you have? List the qualifications, the year each was obtained, and the awarding institution.

| INSTITUTION | QUALIFICATION | YEAR |
|---|---|---|
| | | |
| | | |
| | | |

10. List any courses/awards in which you are currently enrolled..

| INSTITUTION | COURSE/AWARD | EXPECTED COMPLETION DATE |
|---|---|---|
| | | |
| | | |

11. To which professional associations do you belong?

SECTION B : NON-AWARD MATHEMATICS EDUCATION PROFESSIONAL DEVELOPMENT ACTIVITIES.

This section refers specifically to non-award mathematics education professional development activities. A professional development activity is any experience, formal or informal, whether in or out of school time, which is related to your work as a teacher. It includes, for example, in-service courses, meetings, professional association activities, seminars, workshops, action research, and lectures.

1. List the mathematics education professional development activities in which you have been involved in the past twelve months.

2. Which of these activities had positive outcomes for you? What made the activities successful?

3. Which of these activities was least successful for you? What factors contributed to the lack of success?

4. What has provided the motivation for your participation in mathematics education professional activities in the past three years? (For example, received funding, opportunity to meet other teachers, new curriculum documents, etc),

5. Think back over all the mathematics education professional development activities you have experienced in your career. Briefly describe the one that, for you, had the most impact on your teaching, and comment on why you think this was the case.

6 Given sufficient funding and opportunity, what mathematics education professional development activities would you like to participate in at this stage of your career?

SECTION C: MATHEMATICS EDUCATION PROFESSIONAL DEVELOPMENT ACTIVITIES TAKEN AS PART OF AN AWARD PROGRAM.

NOTE: If you have not taken one or more mathematics education units as part of a Graduate Certificate, Graduate Diploma, Bachelor of Education, Master of Education or similar program in the past 5 years, then go immediately to SECTION D.

1. List the mathematics education units/subjects completed in the past five years as part of an award.

2. Which of these units/subjects had positive outcomes for you? What made the unit/subject successful?

3. Which of these units/subjects was least successful for you? What factors contributed to the lack of success?

4. What has provided the motivation for your participation in mathematics education units/subjects as part of award courses in the past five years? (For example, need to upgrade qualifications, desire for promotion, opportunity to meet other teachers, etc),

5 Given sufficient time and opportunity, what further mathematics education units/subjects would you like to participate in as part of an award course.

SECTION D: MATHEMATICS EDUCATION

1. Describe how you feel about your mathematics teaching.

2. Describe a recent incident which has provided some insights into the way young children learn mathematics.

3. Describe a mathematics teaching incident in which you felt that the children were not learning significant mathematics

4. Describe the way in which you plan mathematics activities.

5. List the support services which are available to assist you with your mathematics teaching. Comment on the access you have to these services.

| SUPPORT SERVICE | ACCESS |
| --- | --- |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

SECTION E: PLANNING PROFESSIONAL DEVELOPMENT

Imagine that you have been seconded to a Mathematics Resource Centre. You have been invited to plan a three day professional development activity in Darwin for fifteen early childhood teachers from bush schools, large urban schools and preschools. How would you plan a program for these teachers? What would you include in the program?

**APPENDIX B**

Dear Early Childhood Colleague,

**Survey of mathematics education professional development.**

Attached is a survey which is part of a systematic attempt to document the mathematics education professional development of early childhood teachers in the Northern Territory. *The Discipline Review of Teacher Education in Mathematics and Science* highlighted the need for tertiary institutions to review their pre-service and in-service course offerings and to work with other professional development providers to ensure that the teaching and learning of mathematics in schools reflect current knowledge.

I hope you will be willing to participate in this survey. It is concerned with your professional development experiences in relation to mathematics education. I have attempted to be as comprehensive as possible in the questionnaire but as your individual responses are important please respond in as much detail as you wish.

When data are available a summary will be sent to participating schools. At the conclusion of the research project a brief report of the findings will be available. In the summary and the report, no individual teachers or schools will be identified. Codes will be used for schools for administrative purposes only.

Although you are not asked to provide your name, I would like to interview a sample of respondents so that some issues can be explored in greater depth. If you are willing to be interviewed, please write your name in the box below. This information will be treated confidentially.

When you have completed the questionnaire, please seal it in the accompanying envelope and return it to the researcher.

Your cooperation is greatly appreciated.

Wendy Hawthorne.
Senior Lecturer.

Please place your name in this box if you are willing to be interviewed. ☐

**APPENDIX C**

Early Childhood Mathematics Professional Development Research

This research project aims to collect data which describes the professional development activities of early childhood teachers in relation to mathematics education. It is hoped that, through gaining a better understanding of the interests and concerns of teachers in relation to their mathematics teaching, and the support they receive for this, more effective pre-service and in-service activities can be planned. This will, in turn mean benefits for the children with whom you work.

Initially data will be obtained from a survey of early childhood teachers in Northern Territory government and non-government schools. Survey respondents may also be interviewed if they volunteer. The data will be used to identify trends according to factors such as age, length of experience or access to professional development activities. Individual respondents will not be identified by name or school location.

It is expected that the survey will take approximately 30 minutes to complete and interviews from 30 to 45 minutes. The surveys and interviews will be conducted in Term 2, 1994. A short summary of the results will be sent to you late in 1994.

Any questions concerning the project entitled Early Childhood Mathematics Professional Development Research can be directed to Wendy Hawthorne, Senior Lecturer, Faculty of Education, Northern Territory University on (089) 466152.

Please complete the attached consent form and return it with your completed survey. Thank you.

Wendy Hawthorne.

CONSENT TO PARTICIPATE IN RESEARCH

I, ....., have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

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Participant Date

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Wendy Hawthorne Date

**APPENDIX D**

4th December, 1993

As the school year draws to a close I am sure you are looking forward to a well earned rest. I hope that you have a restful and enjoyable holiday.

I am aware that this is a busy time for teachers but I am hoping that you might find some time over the holiday period or when you return to school to assist me in some research I am carrying out. My Doctoral work is a study of the mathematics education professional development of early childhood teachers. As part of this work I plan to survey about 200 early childhood teachers to obtain information which could provide direction for the planning of future professional development activities. I received permission from the Northern Territory Department of Education to conduct this research in 1994.

I am hoping you might assist me to pilot my questionnaire. I have attached a copy of it and would be grateful if you could take the time to complete it and to offer feedback in relation to completion time, clarity of questions, repetition or overlapping within questions or any other matters.

I am also planning to interview a number of early childhood teachers. I will be back at the university on the 10th January so would be available to conduct interviews from that date if you are willing to participate.

I appreciate that you have many other commitments but hope that you can assist me in my work.

Regards

Wendy Hawthorne
Senior Lecturer, Faculty of Education.

**APPENDIX E**

EARLY CHILDHOOD MATHEMATICS PROFESSIONAL DEVELOPMENT RESEARCH PROJECT

INTERVIEW SCHEDULE FOR CLASSROOM TEACHERS

1. Think about how you teach mathematics. What are your strengths and what are your weaknesses?

2. What are your current concerns and interests in relation to your mathematics teaching?

3. Reflect, for a moment, on you experiences as a learner of mathematics, of your professional training as a teacher (which including mathematics education) and of the professional development activities you have experienced in mathematics education. Comment on these in relation to your own feelings about mathematics and on your feelings about teaching mathematics. How have your overall experiences influenced the way in which you teach mathematics?

4. What sort of professional development program or activities in mathematics education would be of sufficient interest to you that you would be prepared to make a commitment to be actively involved?

**APPENDIX F**

Your willingness to participate in an interview is greatly appreciated. The information that interviewees provide will be confidential to the researcher. A copy of the audiotape and transcript of the interview will be sent to you for verification and alteration if necessary. Publication of results will be in descriptive terms and related to the provision of professional development programs in mathematics education for early childhood teachers. Prior to our interview please complete the consent form below.

CONSENT TO PARTICIPATE IN RESEARCH

I, ....., have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

---

Participant Date

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Wendy Hawthorne Date

**APPENDIX G**

EARLY CHILDHOOD MATHEMATICS PROFESSIONAL DEVELOPMENT RESEARCH PROJECT

INTERVIEW SCHEDULE FOR KEY INFORMANTS

1. Describe your involvement in early childhood mathematics education professional development in the Northern Territory.

2. What do you consider to be the features and strengths of current mathematics education professional development programs for early childhood teachers in the Northern Territory?

3. What do you consider to be weaknesses in the current provision of mathematics education professional development programs for early childhood teachers in the Northern Territory?

4. Please comment on any other aspects of professional development in relation to early childhood teachers and mathematics education in the Northern Territory.

**APPENDIX H**

Your willingness to participate in an interview is greatly appreciated. The information that interviewees provide will be confidential to the researcher. A copy of the audiotape and transcript of the interview will be sent to you for verification and alteration if necessary. Publication of results will be in descriptive terms and related to the provision of professional development programs in mathematics education for early childhood teachers. Prior to our interview please complete the consent form below.

CONSENT TO PARTICIPATE IN RESEARCH

I, ....., have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

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Participant Date

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Wendy Hawthorne Date